SCIENCE ABSTRACTS.

Section A.—PHYSICS.

MARCH 1925.

GENERAL PHYSICS.

464. *A Straight Line Chart for the Solution of Spherical Triangles.* **F. E. Wright.** (Washington Acad. Sci., J. 14. pp. 399–407, Oct. 19, 1924.)—The straight line cosine chart first proposed by d'Ocagne for the solution of the triangle for the spherical distance between two points whose latitudes and longitudes are known has recently been applied by Littlehales to the solution of the spherical triangle required by the Sumner line method of navigation. The range of usefulness of this chart is now extended in the present paper to include the solution of any spherical triangle for which any three angles are known. To attain this result it is necessary to re-label the scales of the d'Ocagne chart, and to assign to each of the six identical scales definite angles of the spherical triangle. A straight line is passed through points on the scales at the sides or the top and bottom of the chart. The unknown angles are then determined by the intersection of this straight line either with a given ordinate or with a second straight line. The accuracy attainable by a chart of this kind is commonly one to two-tenths of a degree of arc, depending somewhat on the angles of the spherical triangle; it may amount to a degree or more in an unfavourable case. The possibility is also suggested of constructing a simple trigonometric computer based on this principle. H. H. Ho.

465. *Experiments on Crystal Structure by Means of Radio-active Substances.* **K. Horovitz.** (Akad. Wiss. Wien, Ber. 132. 2a. No. 9–10. pp. 375–385, 1924.)—In connection with the more recent work on the growth of crystals and adsorption, the necessity is recognized of following what takes place in the new-formed limiting layer. The possibility of doing this offers itself in the use of radio-active gases which are known to be in monomolecular layers. In this paper experiments are described on the adsorption of Th.B.C. vapour at a crystal surface, which appear to make it probable that, in the main, only those atoms are adsorbed of which combination with the electronegative constituent part of the lattice is fugitive. Experiments on polished pieces of zinc-blende with surfaces parallel to the positive and negative tetrahedra show that the adsorption is dependent on the different orientations of the crystal surfaces. A. E. G.

466. *The Measurement of the Lattice Energy of Crystals.* **W. Wessel.** (Zeits. f. Physik, 30. 3. pp. 217–224, 1924.)—It is shown that it is possible to obtain the lattice energy of a salt from the partial pressures of the ions in its vapour; electrostatic measurements of such pressures in atomic streams of saturated vapours are to be desired. The saturated vapour consists chiefly of molecules, some of which have been split up into ions. There is chemical equilibrium between the different constituents, which depends only on the temperature. The equilibrium pressures can be calculated numerically if the different transformation energies and the chemical constants are known. Born and Heisenberg have recently calculated a number of data for the latter [Abstract 2178 (1924)]. Conversely it is possible, when one of the partial pressures can be directly measured, to calculate one of the transformation energies—for example, the lattice energy. The author shows that in the case of binary salts the method of calculation is in many cases quite simple, consisting of the solution of a system of thermodynamical conditions of equilibrium (law of mass action). The theoretical values of the different quantities involved are given for common salt. In simple cases all the constants, including the heats of fusion and evaporation, can be eliminated by taking measurements at three different temperatures, and the lattice energy can then be determined if the partial pressures of the ions are known. H. N. A.

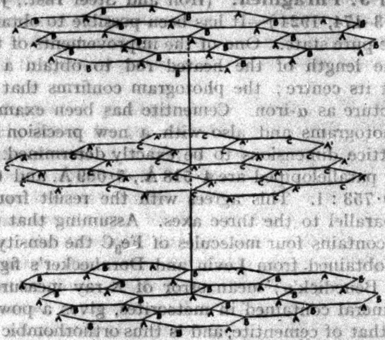
467. *Some Properties of Single-Metal Crystals.* **P. W. Bridgman.** (Nat. Acad. Sci., Proc. 10. pp. 411–415, Oct., 1924.)—Summarises the results of measurements of a number of physical properties of single crystals of the non-cubic metals Zn, Cd, Bi, Sb, Te, and Sn, with a few measurements on tungsten (cubic system). Zn and Cd have a six-fold axis of rotational symmetry; Bi, Sb and Te a three-fold axis; and Sn a four-fold axis; the rotational axis is taken as the datum line. Of the properties measured the elastic constants are the most complicated; the other properties have rotational symmetry, so that the linear compressibility, thermal expansion and electrical resistance are completely determined for all directions if determined parallel and perpendicular to the axis. The tables show that the elastic constants vary greatly with direction. The linear compressibility of Zn is nearly seven times greater parallel to the axis than at right angles, and that of Te is negative parallel to the axis. The deformability is greatest across the principal cleavage or slip plane, except in the case of the effective Young's modulus of Sn. With Cd matters are complicated owing to the existence of two new polymorphic forms under pressure. Thermal expansion is in all cases greatest across cleavage or slip planes. Te shows negative expansion along the axis. Electrical resistance is greatest across the cleavage or slip planes, *i.e.* in the direction in which the atoms are most separated. Sb is an exception. The effect of pressure on resistance is complicated in the case of Bi, and still more so with Sb. It appears that the resistance is determined by something more specific than the mere distance of the atoms, and that the details of atomic structure are involved. H. N. A.

468. *Crystal Structure of Hard Steel.* **K. Heindlhofer.** (Phys. Rev. 24. pp. 426–438, Oct., 1924.)—Using an X-ray spectrometer with ionisation chamber and reflecting Mo Kα and Kβ rays from small blocks of steel, spectra were determined for 0·80 and 1·31 % carbon steels, both in coarse and in fine martensitic condition. The same lines were found as in the spectrum of carbon-free iron, but they were only one-third as intense and were somewhat broader and slightly shifted. Lattice of martensite.—These results confirm the previously reported conclusion that martensite has a body-centred lattice like that of α iron, but show that the lattice is contracted about 0·4 % on a side and is also distorted. This distortion, which changes the shape of the lines, disappears largely, however, after heating the martensite at 260° C. for 30 min., although the hardness is not much decreased. Nature of martensite.—From a comparison of the densities of the specimens with those of α iron and of cementite, it is concluded that martensite is a mixture (1) of a solid solution of carbon in iron, the C atoms replacing the Fe atoms, and (2) of finely dispersed cementite. The solid solution is unstable even at room-temperature. Both constituents seem to contribute to the hardness, the solid solution by distorting the lattice and the cementite by being so fine grained. AUTHOR.

469. *X-Ray Studies on the Crystal Structure of Steel. Part II.* **A. Westgren** and **J. Phragmén.** (Iron and Steel Inst., J. 109. pp. 159–172; Disc., 173–174, 1924.)—It has been possible to obtain a photogram of δ-iron in the pure state. One of the improvements of the method was to increase the length of the heated rod to obtain a more uniform temperature at its centre; the photogram confirms that this phase has the same structure as α-iron. Cementite has been examined by means of rotation photograms and also with a new precision camera, which enables the lattice dimensions to be exactly determined. The edges of the elementary parallelopiped are 4·518 Å., 5·069 Å. and 6·737 Å.; axial ratio 0·671 : 0·753 : 1. This agrees with the result from Laue photograms taken parallel to the three axes. Assuming that the elementary parallelopiped contains four molecules of Fe_3C the density is 7·68. The value 7·59 is obtained from Levin and Dornhecker's figures, and 7·74 from those of Benedick's; mean error of X-ray measurement ± 0·05. Cohenite, a mineral contained in meteorites, gives a powder photogram identical with that of cementite, and is thus orthorhombic and not cubic, as previously supposed. The lattice dimensions of austenite increase in size with increased carbon content. It is shown that this solid solution is not formed by substitution of metal atoms by carbon atoms, but is an additive product. The carbon atoms are situated in the interstices between the metal atoms, which latter occupy the points of a face-centred cubic lattice. H. N. A.

470. *A New Kind of Mixed Crystals.* **H. G. Grimm.** (Zeits. Elektrochem. 30. pp. 467–472; Disc., 472–473, Oct., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—The formation of mixed crystals seems to depend upon three conditions: The two salts must have the same "type of structure" and also the same space lattice; the ionic distances in the lattice must be similar and not differ, at ordinary temperature, by more than 5 %; chemical analogy (strict isomorphism) is not required. Thus the author, experimenting in conjunction with E. Köstermann, G. Wagner and P. Beyersdorfer, found that NaBr would crystallise on a fresh cleavage face of PbS (two compounds of the type MX) in parallel orientation because the three conditions are approximately satisfied, the equality of the ionic distances being due to the fact that the differences in the charges, in the sizes, and in the structures of the ions happen to balance one another, although the ionic charges and the sizes of the respective ions differ strongly. The experiment is fairly successful also with NaCl, but not with RbBr, in the place of NaBr. For similar reasons mixed crystals of NaBr and KOH, and further of BaSO$_4$ and KMnO$_4$ and cognate salts, can be obtained. The chemical properties and colours of the latter are peculiar. Once the KMnO$_4$ has been washed out of the surface layer, the BaSO$_4$ protects the permanganate against attack by chemicals and by sunlight. In reply to **Rinne,** who suggested X-ray studies, and **Paneth** the author stated that in the new mixed crystals pairs of ions seemed to be interlocked and replaceable. H. B.

471. *The Structure of Graphite.* **J. D. Bernal.** (Roy. Soc., Proc. 106. pp. 749–773, Dec. 1, 1924.)—To obtain the orientation of the planes giving the spacings of the powder photographs of Hull and of Debye and Scherrer the rotating crystal method was employed, with a concentric cylindrical film. A few fragments of Ceylon graphite were obtained which, though far from perfect, served the purpose. Measurements on the same crystals were made by Astbury with the ionisation spectrometer, the crystal holder being removed as one piece from one instrument to the other; Laue photograph measurements were also made on them. All the measurements agree with the hexagonal lattice—side of elementary triangle 2·4 Å., height 6·8 Å.—suggested by Hull, the actual figures obtained, using a Müller spectrometer, being 2·45 ± 0·03 Å., 6·82 ± 0·04 Å.; axial ratio $c : a$ = 2·77. Measurements with the same instrument on artificial graphite showed that the cleavage spacings of the two forms do not differ as much as 0·3 %. The volume of the unit cell is 33·5 Å.^{3}, and there are four atoms in each cell. Considering the relative intensities of the reflections, it is finally decided that the atoms lie in a series of layers 3·4 Å. apart (half the height of the unit cell), the atoms being at the corners of the hexagons shown in the accompanying figure. The atoms are actually closer together in the hexagonal nets of graphite than they are in diamond, their centres being 1·42 instead of 1·53 Å. apart. In the absence of other carbon atoms in the immediate vicinity the atoms in the rings seem to draw closer together. The great difference in mechanical properties is due to the atoms being linked closely in a two-dimensional



net in graphite and in a three-dimensional lattice in diamond. In the plane of the cleavage sheets graphite has considerable hardness and tenacity. The carbon atom clearly loses its tetrahedral symmetry in graphite. The proposed structure fits in with the later ideas of Bohr on the structure of the carbon atom; he now postulates three 2_1 orbits and one 2_2 orbit. This form would possess trigonal symmetry only. It is shown diagramatically that such atoms would fit together very naturally in the graphite nets. Diamond may be considered to consist of atoms with four 2_1 orbits. **H. N. A.**

472. *A Contribution to the Theory of Metals.* **J. Frenkel.** (Zeits. f. Physik, 29. 3–4. pp. 214–240, 1924.)—It follows as a direct consequence from the virial law that, in a system of electrically charged particles which always remain at a finite distance from one another, the kinetic and the total energy always change by equal and opposite amounts, so that the more closely the different particles are bound together the quicker they must move. Thus if the atoms of a vapour come together to form a solid or a fluid, the loss of potential energy must be accompanied by an equal gain of kinetic energy in the outer electrons, the movement of the inner electrons being almost unchanged, and the kinetic energy of the thermal movements at ordinary temperatures being negligible compared with the mean kinetic energy of the valence electrons. Owing to the large eccentricity and aphelian distance of their normal quantum orbits, the movements of the valence electrons are so disturbed on condensation of a metal vapour that, instead of continuing to revolve about a single-atom body or ion, they pass at the aphelian position to an orbit about the neighbour ion, to which they are at that instant nearer than to the original one. In this way they pass from ion to ion, moving in a portion of a quantum orbit round each, and so wandering irregularly through the metal. In metals the valency of which is higher than one the electrons may circulate several times round the nucleus before passing to another atom, the self-diffusion and so the electric conductivity being thus reduced. The effect of this self-diffusion is worked out mathematically on the same lines as the Einstein theory of Browian motion, and the effect of a constantly directed e.m.f. is calculated. The values obtained for the electric conductivity and its temperature coefficient agree for high temperature with the experimental data. The heat conductivity can be calculated formally in agreement with the Wiedemann-Franz law, but the mechanism is not explained. The theory is also used to determine the forces of cohesion and the compressibility of metals. Here, although the electrons are not really "free," their general effect is regarded as being the same as that of a continuously distributed fluid, in which the atom bodies (positive ions) "swim." The lattice structure of most metals can thus be explained and their lattice energy calculated. **H. N. A.**

473. *The Calculation of the Magnetic Moments of the Atoms.* **N. Semenoff.** (Zeits. f. Physik, 30. 2. pp. 151–152, 1924.)—Shows that the method employed by Stern and Gerlach [see Abstract 2662 (1924)] to calculate the magnetic moments of the atoms from the results of their observations of deflected and undeflected streams of silver atoms involves a possible error in the worst case of 100 %., but in the best cases of only a few per cent. The magnitude of the error depends directly on the width of the slit. The author starts from the law of distribution of velocity, and calculates the position of the maximum density of the deposit, which he identifies with the middle point of the deflected stream. H. N. A.

474. *The Calculation of the Molecular Diameter from the Heat of Vaporisation and the Surface Tension.* **H. Sirk.** (Phys. Zeits. 25. pp. 545–546, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Making use of the work of Madelung, Born, Courant and Eötvös on surface tension, and Debye's derivation of the static portion, χ, of the surface tension from molecular magnitudes, and assuming that the molecules are spherical and are most closely packed at the absolute zero, the author derives a formula for s, the diameter of the molecules, and in a table gives the resulting values for a number of different elements and compounds, also the values p of the molecular diameter calculated from Ostwald's formula, and of s^*, the molecular diameter calculated by means of the kinetic gas theory. The mean value of s/s^* is 1·37, and of ρ/s^* is 0·38, so that it appears that the values derived from the modern theory agree better with those obtained from the experiments on gases than do those of Ostwald. It is also possible to make use of data obtained by X-ray examination of crystals. Simon and C. v. Simson have obtained 3·8 % 10^{-8} cm. for argon by this means, while the author's formula gives 3·6 % 10^{-8} cm. H. N. A.

475. *The Relation between the Molecular Forces and the Heat of Vaporisation and Surface Tension of a Liquid.* **J. J. Plăcinteanu.** (Zeits. phys. Chem. 113. pp. 290–298, Nov. 8, 1924.)—Assumes that each molecule is acted on by forces from the n equidistant molecules directly surrounding it and by no others. When the distance is d the force vanishes; when it is $d - x$ the force is ax where a is a proportionality factor. If now the resultant force due to shifting the central molecule a distance x is calculated it is found to be $-nax/3$. An expression $P = nNad^2/6V$ is derived from this, for the internal pressure of the liquid, where N is Avogadro's number. The heat of vaporisation r is shown to be given by $r = nNad^2/6M$, where M is the molecular weight. It is next shown that the surface tension $\gamma = nNad^3/12\pi V$, and combining this with the above equation for r gives $Mr/2\pi = \gamma V/d$, which connects the molecular heat of vaporisation Mr with the surface tension. A similar formula has been obtained empirically by Hammick which replaces 2π, in the denominator on the left of the equation, by 6. A table gives the values of $\gamma V/d$, $Mr/6$, and $Mr/2\pi$ for a number of different compounds, and shows in a number of cases quite close agreement. Where the relation does not hold closely Hammick has calculated the degree of polymerisation, which is in agreement with the values calculated by other physicists. H. N. A.

476. *Atoms and Isotopes.* **F. W. Aston.** (Inst. of Metals, J. 32. pp. 3–18, 1924. Engineering, 117. pp. 770–771, June 13, 1924.)

477. *The Isotopes of Mercury.* **F. Stumpf.** (Zeits. f. Physik, 30. 2. pp. 173–174, 1924.)—Aston has found the atomic weights 204, 202, 200 and 197 for the isotopes of mercury. The last number agrees almost exactly with the atomic weight of gold, and there is no other instance among the non-radio active elements of identity in the atomic weights of isotopes. It is suggested that some of the mercury is converted into gold by the discharge, and that the 197 line observed by Aston is due to this metal. Miethe claims to have converted Hg into Au by means of an electric discharge, and it is improbable that Aston's 197 line can be due to gold originally existing as an impurity in the mercury, as the strength of this line does not appear to be very different from that of the others observed. It is suggested that, by receiving this line on plain glass or quartz instead of on a photographic plate, it might be possible to record it as a red line on the glass, since colloid gold colours glass red. Miethe observed red portions on the bulb employed by him, and ascribes the colour to colloid gold. H. N. A.

478. *The Separation of Isotopes by the Ionic Migration Method.* **J. Kendall** and **J. F. White.** (Nat. Acad. Sci., Proc. 10. pp. 458–461, Nov., 1924.)—A preliminary account of the method used has been previously given [Abstract 2336 (1923)]. A number of experiments are here described which show that, for many mixtures, the two components of the mixture are separated by this means, so that at the forward end of the section containing it the faster ion accumulates, while at the rear the slower is found. This is shown by the usual qualitative tests. With barium and calcium the difference in ionic mobilities is about 8 %. A 6 cm. section was moved 200 cm. along the tube; spectroscopic tests were made of different segments, and showed that barium lines were strong in front and absent in the rear, while the reverse was the case for calcium. With a mixture of iodide and chloride, where the mobility difference scarcely exceeds 1 %, a test of the segments with silver nitrate showed that very considerable, though not complete, separation was produced. Lindemann has calculated a difference of 1·7 % betweel Cl^{35} and Cl^{37}, but the experimental results are indecisive. The amount of material in each segment is very small, insufficient for satisfactory quantitative analysis, since the ratio Ag/AgCl varies only by 14 parts in 1000 for Cl^{35} and Cl^{37}. The authors have commenced the construction of a mass-spectrograph, which will be used to test the material of the different segments. Even if complete separation is not obtained, differences in the intensities of the lines of the two isotopes in the front and rear segments may be obtained, which will indicate that a certain amount of separation has taken place. The authors realise that it is extremely improbable that isotopic ions have any marked difference in mobilities, as assumed by Lindemann. The work of Born and of Schmick has shown that it is not probable that the mass of the ion enters into the mobility equation. H. N. A.

479. *An Extension of Bohr's Correspondence Principle to Apply to Small Quantum Numbers.* **P. W. Ketchum.** (Phys. Rev. 24. pp. 463–465, Nov., 1924.)—It is shown that when an electron spirals in from an orbit of quantum number n_2 to an orbit of quantum number n_1, the frequency of the radiation emitted is equal to an integer $(n_2 - n_1)$ times the mean frequency of rotation in its orbit during the spiraling, assuming that the number of rotations made for a change of quantum level dn is proportional to dn. That is, the mean is defined as the ratio to $(n_2 - n_1)$ of the integral from n_1 to n_2 of $\nu_c dn$ where ν_c is the classical frequency of rotation corresponding to any value of n. No explanation is offered as to why radiation begins and stops at integral values of n, nor why the radiation emitted in the manner assumed is monochromatic. AUTHOR.

480. *On the Simultaneous Jumping of Two Electrons in Bohr's Model.* **P. S. Epstein.** (Nat. Acad. Sci., Proc. 10. pp. 337–342, Aug., 1924.)—A new series $(1p - mp')$ has been recently discovered by H. N. Russell and F. A. Saunders in the arc spectrum of calcium, which they attribute to the simultaneous jumping of two electrons. The author discusses the experimental evidence, and concludes that the explanation given is the correct one; he then proceeds to consider the theory, and introduces a very much simplified model of an atom, containing two electrons attached by forces proportional to the distance to two positions of rest O_1 and O_2, and able to move only in the straight line O_1O_2. He first discusses the case where the distance O_1O_2 or a is so large that the force of coupling between the two electrons is negligible compared to the forces of attachment, and obtains harmonic oscillations which he subjects to quantum restrictions; and, using Bohr's principle of correspondence, arrives at the possible jumps which can occur, which are in accordance with the selection principle. The quantic numbers can only change by zero or unity, and only one of the electrons can jump at a time. He then proceeds to deal with the general case, when the coupling cannot be neglected, and finds that a number of additional combinations are now possible. The selection principle breaks down in two respects. Besides the change of a quantic number by one or zero there is a possible change of two units; also both quantic numbers may change by unity at the same time, corresponding to the simultaneous jumping of two electrons. These results will not change essentially in an actual Bohr atom.

H. N. A.

481. *The Constants of the Rydberg-Ritz Equation.* **J. H. Jones** and **J. C. Boyce.** (Roy. Soc., Proc. 106. pp. 773–784, Dec. 1, 1924.)—Considers spectra arising from the radiation of a valence electron when it is alone in the outer shell. The kernel is for the atoms and ions considered probably a structure similar to the atoms of the inert gases, but somewhat smaller owing to the greater nuclear charge. Instead of considering the discrepancy between hydrogen and hydrogen-like spectra, with Fues, as being due to a quantum defect, the authors assume integral quantum numbers and a variation of the effective nuclear charge. The terms are larger, and the effective nuclear charge greater, than the simple theory would predict, and the excess of charge may be called the screening imperfection ξ, and $T = R(Z - b + \xi)^r/n^r$, where T is the spectral term in wave numbers, b the number of screening electrons. A table gives ξ for NaI, MgII singly ionised, AlIII and Si IV for the s, p_1, p_2, d and f series. The values approach zero for orbits at a great distance from the kernel, and increase for higher ionisation when the ratio of the radius of the valence orbit to that of the kernel decreases. This suggests the presence of a small electric doublet at the nucleus, which moves with the valence electron and which increases the electric intensity at neighbouring points, but is ineffective at greater distances. The structure of Sommerfeld requires a repulsive rather than an attractive doublet, and in the Ritz formula the values of ϕ_1 would be inversely proportional to the third power of the azimuthal quantum number; the actual known correction terms are proportional to a much higher inverse power. Lord Rayleigh has observed that the inert gases behave like conducting spheres of atomic dimensions. It is assumed that the kernels in question behave in the same way, and an equation is found for ϕ_1 which gives values which are of the same order as those deduced by Born and Heisenberg from the spectral series in the cases of NaI, MgII, AlIII, SiIV, neon type; KI, CaII, argon type; RbI, SrII, krypton type; and CsI, xenon type. There is much in the original paper which cannot be included in the space available. H. N. A.

482. *The Michelson Experiment: a Possible Thermic Perturbation.* **E. Brylinski.** (Comptes Rendus, 179. pp. 559–562, Sept. 22, 1924.)—A heating effect of from 0·01 to 0·001° C., such as would be produced by the presence of the observer, would produce, superposed on the deviation indicated by the ordinary theory, a phenomenon periodic with the rotation the same as that brought to light in 1921 by Miller. Besides, variations in the thermal effect are capable of inducing considerable variations in the experimental results. The use of invar bars is indicated instead of steel. [See Abstract 430 (1924).] A. D.

483. *The Michelson Experiment and Relativity.* **A. Metz** and **E. Brylinski.** (Rev. Gén. d'Él. 16. pp. 891–893 and pp. 894–895, Dec. 6, 1924.)—Brylinski holds [see Abstract 1398 (1924)] that on the ordinary theory of light, assuming the ether not to be dragged by moving matter and the velocity of light to be independent of the motion of its source, the Fitzgerald contraction is very improbable and the Michelson experiment could not verify the postulates which lie at the base of the relativity theory. **Metz** criticises Brylinski's methods and conclusions. **Brylinski** rebuts the arguments, pointing out that the phenomena adduced in support of the relativity theory are all susceptible to other explanations; that it never has been the case that the Michelson experiment gave entirely negative results, as relativity would require; and that if it had done so, this could be explained in several different manners. A. D.

484. *Ether-Drag and Astronomical Aberration.* **E. Brylinski.** (Rev. Gén. d'Él. 16. pp. 983–986, Dec. 20, 1924.)—Ether-drag would explain the alleged negative results of the Michelson experiment, but it has been objected that it would be inconsistent with the observed facts of aberration. The author shows that this is not necessarily so. If a sufficiently large volume definitely bounded be dragged along, the observer on the earth would make observations only inappreciably differing from the observed aberration, and similarly if the drag shades off to a sufficiently great distance. A. D.

485. *An Objection to the Special Relativity Theory.* **H. Thirring.** (Zeits. f. Physik, 30. 1. pp. 63–65, 1924.)—Quotations are given from papers by P. Lenard, R. Tomaschek and M. la Rosa [see Abstracts 770, 2207 and 2903 (1924)], in which it is stated that, according to the special relativity theory, the rotation of double stars gives rise to an aberration effect. The author shows that this view is incorrect, and the error arises from a failure to consider the time taken by the light to travel from the star to the earth. R. S. R.

486. *New Experiments in Gravitation.* **C. F. Brush.** (Am. Phil. Soc., Proc. 63. 1. pp. 57–61, 1924.)—The present author outlined a kinetic theory of gravitation in December 1910 and has since published several papers on gravitation of an experimental nature. [See Abstract 375 (1924).] The latest one seemed to show that certain substances fell quicker than others, though each is in a similar containing vessel. The results are qualitatively summed as follows :—

Table of Relative Falling Velocities.

Fast : Platinum.
Gold coin, tungsten (forged), lead.
Bismuth.
Zinc, tin.
Slow : Aluminium, magnesium, carbon, silicon, boron, water.
Sulphur, selenium.

The observed difference in the falling velocities of platinum and sulphur (lag of the sulphur) is about 0·02 cm. in the 122 cm. of fall, or about 1 part in 6000. The work is still in progress, and further papers are promised. E. H. B.

METEOROLOGY AND GEO-PHYSICS.

487. *Shape of the Blue Sky.* **A. Müller.** (Ann. d. Physik, 75. 6. pp. 653–656, Nov., 1924.)—The apparent form of the blue sky does not correspond to an actual physical boundary. The former is purely psychological, and any attempt to identify it with an optical-atmospheric physical boundary is futile, however the latter may be defined. Figures are given showing the great differences between actual and apparent shape. G. A. S.

488. *Oscillations of the Atmospheric Circulation over the North Atlantic Ocean.* **A. Defant.** (Geografiska Annaler, 1. pp. 13–41, 1924. Monthly Weather Rev. 52. pp. 387–393, Aug., 1924. Abstract.)—From the monthly departures of air-pressure over the North Atlantic from normal during the period 1881–1905 the mean meridional distributions have been obtained for each 5° of latitude between 10° N. and 75° N. The resulting distributions may be broadly classified according to whether there is a positive pressure anomaly in the north associated with a negative pressure anomaly in the south, or *vice versa.* The number of examples of each type are approximately equal, and the sequence of the types gives a periodicity of about eight years. A study of the variations of meridional pressure gradients in the region 30°–65° N. latitude and the west-east gradient in the North Atlantic suggests that the oscillations of the atmospheric circulation are largely caused by variations in the relative intensities of the Icelandic depression and the Azores high. The correlation between the force of the north-east trade wind and that of the atmospheric circulation in the temperate latitudes of the North Atlantic is greater in winter than in summer, but always indicates that they are closely related ; the correlation between the pressure gradients and the character of the ice year near Iceland is also high.

The records considered do not cover a long enough period for conclusions to be drawn concerning any relationship between oscillations in the atmospheric circulation and the sunspot period. It appears possible that the greater volcanic ash eruptions are accompanied by a decrease in the circulation, which is followed by oscillations of the circulation about its equilibrium position, the period of the oscillations being about 3·5 years. A. W. L.

489. *Records of Total Solar Radiation Intensity and their Relation to Daylight Intensity.* **H. H. Kimball.** (Monthly Weather Rev. 52. pp. 473–479, Oct., 1924. Paper read before the British Assoc., Toronto, 1924.)

490. *Formation of Cyclones.* **V. Bjerknes.** (J. de Physique et le Radium, 5. pp. 321–330, Nov., 1924.)—The author describes the mode of formation and propagation of cyclonic disturbances in the atmosphere. The disturbances arise in the regions where the surfaces of equal density do not coincide with the surfaces of equal pressure. The disturbances arising on a surface of discontinuity are investigated, and the vortex motion resulting is shown to possess features identifiable with the observed properties and development of cyclonic movements. A. Wh.

491. *Heliocentric Velocity of Meteorites.* **J. Hepperger.** (Akad. Wiss. Wien, Ber. 132. 2a. No. 9–10. pp. 323–342, 1924.)—Although it is usually assumed that meteorites are moving in almost parabolic orbits round the sun, like comets, it was already shown by v. Niessl in 1878 that the crowding of their radiants towards the apex of the earth's way and the diurnal variation in their frequency indicate that many meteor-streams are not interplanetary, but are interstellar, pursuing strongly marked hyperbolic paths. This paper is a mathematical investigation into the mean velocities of meteorites with regard to the sun, deduced from observations of their motions when they are attracted by the earth and become visible in our atmosphere. A further paper will deal with the influence of zenith attraction on meteorite frequency. M. A. E.

492. *On the Size of the Block of the Earth's Crust which may be Independently in Isostatic Equilibrium.* **W. Bowie.** (Washington Acad. Sci., J. 14. pp. 355–362, Sept. 19, 1924.)—For a test of regional *versus* local distribution of compensation data for 124 stations in the United States have been published [see Abstract 1090 (1917)]. Summaries are now given, from which a careful analysis indicates there to be no choice between the distribution locally and that regionally to 12 and 37 miles ; but when the anomalies to 104 miles are inspected, it is found that there are larger anomalies than for the other distributions. As the compensation of the topography extends to a great depth below the surface, of the order of magnitude of 60 miles, the computed effect is found to be practically the same, whether distributed for a reasonable distance around the feature or directly beneath it. Evidence is given showing the effect on gravity anomalies of not taking into account the negative attraction of the compensation of the topography within certain distances of 42 stations, each of which has an elevation of more than 3000 ft. The gravity anomalies and abstract reasoning both favour the idea that even masses of moderate size above sea-level are not extra loads on the crust. The anomalies, however, do not furnish the knowledge, whether the compensation is directly under a topographic feature or distributed in the crust at some distance horizontally from the column directly below the feature. The author believes the theory of isostasy to be substantially true, and that the cross-section of the isostatic unit is from 25 to 50 miles in radius.

H. H. Ho.

ASTRO-PHYSICS.

493. *Parallaxes of Fifty Stars.* **C. P. Olivier.** (Astron. J. 35. pp. 189–190, Aug. 28, 1924.)—These were determined by photography with the 26-inch refractor at the Leander McCormick Observatory, U.S.A., and the list is in continuation of six others given in former numbers of the *Astronomical Journal.*

M. A. E.

494. *Mean Parallaxes of Stars of Small Proper Motion.* **F. H. Seares.** (Mt. Wilson Observat. Contrib. No. 282. Astrophys. J. 60. pp. 175–191, Oct., 1924.)—Distribution functions for small values of stellar velocity.—In Abstract 2701 (1924) it was shown that if the logarithms of space velocities have a Gaussian distribution the frequencies of small tangential velocities are sensibly proportional to the velocity. Here it is found that for small values of the space-velocity the Gaussian law for space-velocity cannot hold, or at least is very improbable. This, however, does not appreciably affect the results for tangential velocity. General considerations show that the frequency function for small tangential velocities, whether corrected or uncorrected for solar motion, has the form

$$N(T)dT = (D_0 + D_1T + D_2T^2 + \ldots)TdT \qquad (T \lesssim \tfrac{1}{3}\underline{T})$$

where D_1, D_2, etc., are zero or small in comparison to D_0. For $T > \underline{T}/3$ the Gaussian function of log T is applicable, as shown in Abstract 2701 (1924). Mean parallaxes for small proper motions.—The law for small tangential velocities, combined with the luminosity and density functions, leads to simple algebraic expressions, equations (27) and (30), for the mean parallaxes of stars of magnitude m and proper motion zero. The mean parallaxes for $\mu = 0$ thus found are finite, whereas a formula of the type proposed by Kapteyn, which presupposes a Gaussian distribution of log T for all values of T, gives zero values of the parallax for $\mu = 0$. For small but finite proper motions values of T, both larger and smaller than $\underline{T}/3$, must be taken into account, and both forms of the frequency function appear in the expression for mean parallax. The resulting formulæ, equations (38) and (47), are functions of the probability integral. Computations for $m = 5$ and $\mu = 0''\cdot005$, $0''\cdot01$, $0''\cdot02$, and $0''\cdot04$ show that the deviations from Kapteyn's formula begin to be appreciable at $\mu = 0''\cdot03$ or $0''\cdot04$. The limiting μ for other values of m should not differ greatly from this value. Comparisons with van Rhijn's mean parallaxes.—The formulæ developed here for zero and small proper motions give mean parallaxes agreeing with van Rhijn's tables as well as can be expected in view of our imperfect knowledge of the coefficients of the density function.

AUTHOR.

495. *Statistical Distribution of Mass among the Stars.* **E. B. Wilson** and **W. J. Luyten.** (Nat. Acad. Sci., Proc. 10. pp. 394–398, Sept., 1924.)—The distribution of mass among certain groups of stellar systems is investigated. The number of stars and doubles of which the mass is known accurately is too small to give reliable results, and while apparent normality of distribution is indicated, it is pointed out that such a distribution makes stars of very great mass, such as the Plaskett binary or υ Sagittarii, almost inconceivably unlikely. A. Wh.

496. *Ages and Masses of Stars.* **J. H. Jeans.** (Nature, 114. pp. 828–829, Dec. 6, 1924.)—The author defines "sub-electronic" and "super-electronic" energy, the latter being insignificant as compared with the former, but is generally supposed to be the source of radiation for the sun and stars. But if a source of stellar radiation is due to the destruction of matter in a star's interior—say by the falling together and consequent annihilation of the positive and negative electron charges—then Eddington's relation between luminosity and mass [see Abstract 1730 (1924)] fixes the rate at which the stars lose these, and gives the interval of time between our sun and Sirius, or some giant star of 10 times the sun's mass, as of 6 to 7 times 10^{12} years—a much greater period than hitherto allowed for the ages of the stars. This conception of diminishing masses indicates that the solar system and the whole universe of stars also are expanding, and if the average star of the past were 4 times as massive as that of to-day, then the universe at that epoch was 64 times more closely packed. This period of time (6 or 7 times 10^{12} years) would also satisfy the partial conformity to the "equipartition law" of the orbits of binaries (and possibly the ratios of the masses of their components) and of the velocities of the stars in space. It also increases the chance for solar systems to be formed by tidal action. A. S. D. M.

497. *Evolution of Stars and Diameter of Sun.* **M. Hamy.** (Comptes Rendus, 179. pp. 1012–1015, Nov. 17, 1924.)—The author discusses the effect of Eddington's relation between stellar mass and luminosity [see Abstract 1730 (1924)] on Russell's giant and dwarf theory, and shows that this has increased the duration of the universe. He suggests a method of measuring the secular contraction of the sun—that is, of its angular diameter. This he has done already for a star of uniform brightness [see Abstract 73 (1922)], but his investigation is applicable, to a first approximation, to the sun, whose surface brightness diminishes because of atmospheric absorption from centre to limb. He represents analytically the angular intrinsic brightness ϵ of a point on the disc as a function of the distance ρ from the centre, the radius being taken as unity, and obtains the convergent series

$$\epsilon = A_0 + A_1\sqrt{1-\rho^2} + A_2(1-\rho^2) + \ldots + A_n(1-\rho^2)^{n/2} + \ldots ,$$

and for the first five terms of this he finds results in good agreement with modern observations. A. S. D. M.

498. *Convection Currents in Stars.* **C. E. St. John** and **W. S. Adams.** (Nat. Acad. Sci., Proc. 10. pp. 392–394, Sept., 1924.)—Old high-dispersion spectrograms of Sirius, Procyon and Arcturus are re-examined in the light of more recent knowledge. Measurements of the relative shift between enhanced and arc lines, known to correspond to high and low-level lines, shows that the convection current effect found in the sun appears also in these stars. The relative pressures in these stars are also estimated from the shift of groups of lines of which the pressure coefficients are known. In all cases the pressures seem to be of the same order as those in the sun. The convection current velocities seem to increase with the temperature of the star, while the density may also be a factor. A. Wh.

499. *System of σ Cygni*. **F. Henroteau.** (Roy. Astron. Soc. Canada, J. 18. pp. 339–342, Oct., 1924.)—The spectrum is B8*p*, and shows the sharp, narrow *c* characteristic of pseudo-cepheids, though its period of about eleven days is too long for this type. The author determined its spectroscopic orbit in 1916; and in 1920 Guthnick, with a photoelectric cell, found it slightly variable, with an amplitude of variation of $0^{m}\cdot05$ or more, indicating the Algol type, with a duration of eclipse of two or three days and a darkening of 0·00070. This shows, if the smaller body is dark, that the ratio of the surfaces of the two bodies is 1/25. The author infers that the secondary body is only of the status of a planet. This is the first indication of a planetary system attached to a sun other than our own. A. S. D. M.

500. *Corrections to List of Spectroscopic Binaries*. **H. H. Plaskett.** (Roy. Astron. Soc. Canada, J. 18. pp. 367–369, Oct., 1924.)—Through uncorrected errors in the measures and reductions of a list of 88 spectroscopic binaries four Boss stars (Nos. 37, 348, 3011 and 5126) were classed as such, whereas they are now found to have constant velocities.
A. S. D. M.

501. *On the Nature of Spectroscopic Binaries of Short Period*. **O. Struve.** (Astrophys. J. 60. pp. 167–174, Oct., 1924.)—An investigation of observational data for 144 spectroscopic binaries shows: (1) That the relation between the period P and the semi-amplitude of velocity variation, K is in agreement with the double-star hypothesis for periods longer than 2·4 days; (2) that for Cepheid variables there is no change in K corresponding to a change in P; (3) that spectroscopic binaries having periods less than 2·4 days consist of two distinct groups of stars. The more numerous group is characterised by small values of K, which is practically the same as for Cepheid variables. Apparently these stars are not double stars, but are closely related to the Cepheids. The other, less numerous group is characterised by large values of K, indicating that these stars are actually double. On account of their small orbital dimensions, these stars are probably to a large extent eclipsing variables, as, for example, W Ursæ Majoris. In a given particular case it is not always possible to decide whether a star belongs to the "pseudo-Cepheids" or to the real double stars. This is due to the uncertainty of *i* in any given case. The average total mass was determined for those of the 144 spectroscopic binaries which are probably actual double stars. This mass was found to be about three times the mass of the sun. The average spectral type of the stars investigated was found to be A4. AUTHOR.

502. *The Orbit of the Spectroscopic Binary* 43 θ^2 *Orionis*. **O. Struve.** (Astrophys. J. 60. pp. 159–166, Oct., 1924.)—The period and the orbital elements of the spectroscopic binary 43 θ^2 Orionis were derived from the measurements of thirty-nine plates obtained with the Bruce spectrograph of the Yerkes Observatory. Within an interval of twenty years there seems to have been no appreciable change in the period, due to the resistance of the nebula. The velocities obtained from the emission lines of hydrogen and from the dark K line of *Ca* do not participate in the periodic shifts of the other lines. The mean velocity of these lines (emission and *Ca*K) is nearly the same as that of the nebula, and justifies the assumption that these lines are produced by the nebula. The velocity of the centre of mass of the star is more than 20 km./sec. larger. The Orion nebula, as well as the calcium gases producing the stationary *Ca* line K, are nearly at rest with respect to the system of stars from which the motion of the solar system has been computed. AUTHOR.

503. *The System of* 61 μ *Orionis.* **E. B. Frost** and **O. Struve.** (Astrophys. J. 60. pp. 192–200, Oct., 1924.)—Observations of the star 61 μ Orionis were begun at the Yerkes Observatory in 1905, and a table of the measured velocities from 124 plates obtained in the intervening years is given. The period is found to be $4^{d}\cdot 447$, and $a \sin i = 2{,}000{,}000$ km./sec. The eccentricity is found to be $0\cdot 01$, indicating a circular orbit. The velocity in the line of sight of the centre of mass varied from 44 km./sec. in 1907 to 37 km./sec. in 1915, and back to 43 km./sec. in 1922, indicating the presence of a third body. In 1914 Aitken found that μ Orionis was a visual double, the fainter component being of magnitude $6\cdot 6$, separation $0''\cdot 36$. A table of seven observations of this companion is given from the measures of Aitken and van Biesbroeck. Tentative elements derived for the orbit of the visual binary are: $P = 18$ years; $\gamma = 40\cdot 8$ km./sec.; $K = 4\cdot 0$ km./sec.; $\omega = 98°$; $e = 0\cdot 6$; $T = 1911\cdot 7$; $a \sin i = 300{,}000{,}000$ km. The indications are that $\sin i$ is in the neighbourhood of unity, so that the distance of the visible companion from the spectroscopic binary is approximately two astronomical units. Assuming the parallax to be $0''\cdot 03$ and that $\sin i$ is nearly equal to unity, the mass of the visible companion is found to be $1\cdot 2\,\odot$, while the masses of the components of the spectroscopic binary are $2\cdot 1\,\odot$ and $1\cdot 7\,\odot$ respectively. Further observation through an entire period of the visual binary is considered necessary. AUTHOR.

504. *O-Type Stars and their Relation to Stellar Evolutionary Sequence.* **J. S. Plaskett.** (Roy. Astron. Soc. Canada, J. 18. pp. 321–338, Oct., 1924.)—The first eleven pages are historical, dealing with the work of Jeans on evolution of the nebulæ [see Abstracts 804 and 1102 (1924) and of Eddington on physical conditions in the stars [see Abstracts 1806 (1923) and 1730 (1924)]. The author then divides the O-type stars into three sub-classes: (*a*) Emission or Wolf-Rayet stars, whose spectra are uniquely characterised by broad, bright bands with no absorption; (*b*) absorption stars, with spectra containing absorption lines and occasional narrow emission lines; (*c*) planetary nebulæ, whose central nuclear stars are always emission or absorption O-type stars. All three classes have elements principally of hydrogen, helium, and of ionised helium, carbon, nitrogen, oxygen, and silicon. Neither mass nor radial motion is measurable for Wolf-Rayet stars, but for the rest the author finds: For the *mass* of an O-type star the range is 10 to 80 times the solar mass; for *temperature* it is as high as 20,000 to 30,000 degrees; for *radial motions*, $25\cdot 5$ km. for absorption O-type and 30 km. for planetaries as compared with 17 km. for M-type and $6\cdot 5$ km. for B-type (in this the O-type stars stand out from the evolutionary sequence); in *tangential motions* all three sub-classes resemble the N-stars at the other end of the spectral sequence in being very small; in *distance* they are so remote that ordinary trigonometrical methods are useless, but three forms of statistical methods give the order of 3000 light years; in *distribution*, unlike the N-stars, they are closely confined to the plane of the Milky Way, but are fairly uniformly spaced in galactic longitude; in *luminosity* they range from 1000 to 15,000 times the sun's brightness. The author considers that the Wolf-Rayet stars develop as a sort of side chain from the absorption stars, and apparently at any stage of the temperature sequence of the latter, and suggests that the instability, due to radiation pressure approaching equality with the gravitational forces for masses over 50 times that of the sun, may cause eruption of emissive material, and so produce a Wolf-Rayet star. He concludes that O-type stars are placed at the very apex of the evolutionary sequence. [See Abstract 813 (1924).] A. S. D. M.

505. *On Motions, Mean Distance and Luminosities of Class O Stars.* **R. E. Wilson.** (Astron. J. 36. pp. 1–11, Oct. 15, 1924.)—A table is given of the positional data, spectra (according to the Revised Harvard Draper and to the new Victoria Classification) and proper motions of 84 stars; it exhibits the comparatively large range in apparent magnitude, 2·2 to 10·5, and the size of the proper motions, the largest being 0″·055 per annum. All lie near or in the Galaxy; 54 lie between R.A. 6 hrs. and 18 hrs., and so are unfavourably situated for giving the solar motion, but the author derives, by Bravais' method, $A = 260^\circ\cdot 5$, $D = +36^\circ\cdot 6$, $q = 0''\cdot 0111$. From the radial motions of 49 stars, though 40 are near the apex or antapex of solar motion, the author derives by Airy's method $A = 263^\circ\cdot 2$, $D = +35^\circ\cdot 2$, $V_\odot = -31\cdot 7$ km./sec. This value of the solar speed differs widely from Plaskett's $V_\odot = -23\cdot 8$ km./sec. With such small proper motions spurious error becomes very effective, and the author shows how this can be partially eliminated. A table gives the mean parallaxes and absolute magnitudes computed from the corrected proper motion components, the data being grouped according to type and apparent magnitude. The conclusion is forced that the dispersion in distance of class O stars is small, and that, for statistical purposes, these may be taken as situated in a ring, the plane of which lies about in the plane of the Milky Way at a mean distance about $\pi = 0''\cdot 0013$. It follows that there must exist a total range of luminosity of 7·8 magnitudes, which is inconsistent with placing the type at the head of the spectral sequence. In general, the brighter class O stars appear so because of greater intrinsic luminosity rather than because they are near. The author explains this by Eddington's conclusions that stellar luminosity depends primarily on mass. The real motions of the O stars are large. A. S. D. M.

506. *Solar Motion derived from Proper Motions of Tenth Magnitude Stars.* **H. L. Alden** and **P. van de Kamp.** (Astron. J. 36. pp. 17–23, Oct. 25, 1924.)—The authors investigate the proper motions, both in right ascension and declination, of 321 Boss stars in 87 different regions, relative to a total of 1905 comparison stars of mean photovisual magnitude 10·14. They find from these the solar apex as $A = 285^\circ\cdot 8 \pm 5^\circ\cdot 3$, $D = +43^\circ\cdot 6 \pm 5^\circ\cdot 2$, confirming the slight increase in the R.A. of the apex and the marked increase in the declination of faint stars as compared with brighter. From the new proper motions in the 1925 *American Ephemeris* they derive $A = 276^\circ\cdot 1 \pm 5^\circ\cdot 3$, $D = +18^\circ\cdot 3 \pm 5^\circ\cdot 2$, the most striking difference being in the declination of the apex, but this is confirmed from the value derived from the brighter stars in the *Ephemeris.* The mean annual parallax of 10·1 magnitude stars is 0″·0030 at galactic latitude 45°. A. S. D. M.

507. *Luminosity Curve for Giant Stars in the Smaller Magellanic Cloud.* **H. Shapley.** (Harvard Coll. Obs., Circ. 260. pp. 1–6, 1924.)—The luminosity curve for stars in general, including all spectral classes, is as yet very imperfectly known, because of insufficient parallax data; but for giant stars in several globular and open clusters it is fairly well known, and it has been found that there is a preliminary maximum in these at an absolute magnitude slightly brighter than zero. To find the relative frequency of the most luminous stars in the Small Magellanic Cloud the apparent magnitudes were determined for 6800 stars in six selected areas, and their absolute magnitudes were deduced on the basis of the recently determined distance of the Cloud [see Abstract 2465 (1924)]. It appears that absolute magnitude zero corresponds with apparent photographic magnitude 17·5, and that just above this point the luminosity curve shows an irregularity of the same general nature as that found in the globular clusters above mentioned. The curves indicate that the brightest stars in the Cloud are between absolute magnitudes − 7 and − 4 (that is, the highest stellar luminosities ever found), and these stars are apparently mainly red. The probable total number of stars in the whole Cloud brighter than absolute magnitude zero is 262,000. Estimates of the probable amount of light contributed by stars fainter than those investigated (*i.e.* fainter than 18th photographic magnitude) lead to the conclusion that either there are very few stars fainter than absolute magnitude zero in the Cloud or that its integrated apparent brightness much excels that of first magnitude stars. The Cloud seems to be a million times more luminous than the spiral nebulæ, which obliges us to abandon either the theory that the Magellanic Clouds are closely related to the spirals or the interpretation of spiral nebulæ by Jeans. Moreover, with the masses and distances of spirals deduced by Jeans, the total mass of all spiral nebulæ within 100,000 light-years, in high galactic latitudes, considerably exceeds that of the stars within the same distance, most of which are relatively near the galactic plane. Such a distribution of mass is incompatible with observed stellar motions, and even with the existence of the Galaxy. M. A. E.

508. *Observations of Asteroids at Yerkes Observatory.* **G. van Biesbroeck** and **O. Struve.** (Astron. J. 36. pp. 11–15, Oct. 15, 1924.)—The observations of faint asteroids were made with the 40-in. refractor and 24-in. reflector, and the examinations were made in the blink-comparator of pairs of plates exposed for twenty minutes in immediate succession. Rough positions are given of fifty known asteroids observed. Special observations given for *Hygeia, Aurora, Andromache* and *Rhoda* were made with the 40-in. Accurate positions are given of nine new asteroids (YO 10 to YO 18). There is a list of thirty-three missing asteroids. A. S. D. M.

509. *Means by Tenth-Years in Latitude Variation.* **J. Boccardi.** (Comptes Rendus, 179. pp. 1240–1251, Dec. 1, 1924.)—The author recites and explains four principal inconveniences in the taking of the means of latitude ϕ by tenths of a year: (1) The short-period terms in ϕ are masked; (2) the total amplitudes of the variations of ϕ are diminished; (3) the intervals of time between the mean value ϕ_0 and the maximum or minimum value of ϕ are falsified; (4) a continual displacement of the pole towards one of the stations, of a secular character, may be introduced from the means of the tenth-years. An erratum is given for p. 1251, line 8, where *30 hours* should read *304 days.* A. S. D. M.

510. *Absorption of Light in Open Star Clusters.* **P. ten Bruggencate.** (Zeits. f. Physik, 29. 5. pp. 243–263, 1924.)—A comparison of colour-indices with absolute magnitudes of stars in the open clusters N.G.C. 1647, Præsepe, and the Hyades shows that these clusters are composed almost exclusively of dwarfs. Their colour-magnitude diagrams, compared with the diagram of the star system in general, show discordances similar to that found for the Pleiades [see Abstract 55 (1925)], in that the absolute magnitudes of the stars in these clusters (derived from apparent magnitude and parallax) are fainter than they would be if in agreement with the Mt. Wilson colour-curve for the star system. This faintness is explained by assuming the presence of absorbing matter. In the case of N.G.C. 1647 outlying streamers of the dark Taurus nebulæ may be between us and the cluster, and in the case of Præsepe and the Hyades there may be nebulosity within the clusters. The presence of nebulosity within clusters is explained in the following way: Stars sufficiently massive to reach the B- and O-type stages pass thence into planetary nebulæ, which (it is suggested) are stars unstable by reason of their great mass and high temperature becoming stable again by throwing off part of their substance. Clusters, therefore, which are now so old that their originally massive stars have passed through the planetary-nebula stage and have become dwarfs contain dark nebulosity, while closer and therefore younger clusters, like the Pleiades, consisting largely of giants which are still shedding, or have but recently shed, their superfluous substance contain nebulosity still shining and visible. Globular clusters, on the other hand, are so young that their stars have not yet reached the unstable stage, although its first signs are perhaps traceable in the cluster-variables and super-giants, and this kind of cluster therefore contains no nebulosity. M. A. E.

511. *New Instrument for Determining both Latitude and Time.* **E. Paloque.** (Comptes Rendus, 179. pp. 1306–1307, Dec. 8, 1924.)—A practical method of observing the simultaneous transit of two stars of the same azimuth. The optical axis of the telescope is maintained horizontal either by floating it in a mercury bath or by suspending it on a knife-edge. The images of the stars are presented as short lines, not points, and the direction of the corresponding star is normal to the plane defined by the line-image and the optical centre of the objective. This is brought about by pentagonal prisms, two of which are used, moving independently of each other, one covering the whole of the objective, the other a half, but symmetrically as regards the centre. Three parallel and horizontal wires in the focal plane of the telescope are disposed so that they divide the line-images into three portions; the observation consists in noting the instant when the intermediate parts of these lines are centrally cut. The two stars have then the same azimuth. Corrections have to be applied for errors in the theoretical angles of the prisms and for the level of the optical axis of the telescope. A. S. D. M.

512. *Optical Planetarium at Munich.* (Nature, 114. pp. 937–938, Dec. 27, 1924.)—In this type the mechanical apparatus is compact, and the images of the planets are projected optically on the surface of a large hemispherical dome, together with images of the fixed stars, so that the motions are represented on a short time-scale as they actually appear to a terrestrial observer. Pictures are given of the planetarium in use and of the projection apparatus, which is mounted upon a polar axis so that the projected images move as in diurnal motion. The planets are projected separately and their motions are seen as from the earth, their orbits being taken as circular. There are also sun and moon projections, the latter being somewhat complicated. The precession of the equinoxes is allowed for in the mechanism, and the whole apparatus is driven by an electric motor. A. S. D. M.

513. *Observations of Remarkable Cloudy Protuberances recently appearing on Mars.* **F. Baldet** and **E. M. Antoniadi.** (Comptes Rendus, 179. pp. 884–886, Nov. 3, 1924.)—The paper contains a description, with seven illustrations, of certain protuberances observed on various days during October, 1924, on Mars. They are attributed to vast clouds floating in the Martian atmosphere rather than to high mountains. H. H. Ho.

514. *Periodic Orbits for Characteristic Planets.* **L. A. Hopkins.** (Astron. J. 36. pp. 25–33, Nov. 11, 1924.)—"Characteristic planets" are those asteroids whose undisturbed mean motions with the mean motion of Jupiter form ratios in which the numerators are greater by unity than the denominators, and are said to be of type $(n+1)/n$, where n is an integer. *Hecuba* is of the type 2/1, *Thule* of the type 4/3. If e = eccentricity and a = mean distance of asteroid, then if $e = 0$, the asteroid describes a circle about the sun of radius $a < 1$; and if $e = 1$ the orbit is one of ejection from the sun. Between these two values of e the asteroid ejects from Jupiter's position when $e = 1/a - 1$. A table is given which exhibits the resulting range for e in the several characteristic types. The author investigates the types 2/1, 3/2 and 4/3, and finds the following common properties for them, which are therefore probably common to all characteristic types: (1) If the asteroid starts from perihelion at conjunction with Jupiter, the period is shortened for small values of the undisturbed e and lengthened for sufficiently large values; (2) except for the 2/1 type, there is one positive value for e for which the period remains constant—namely, that which causes the asteroid to pass through Jupiter's position; (3) if the asteroid starts from aphelion at conjunction with Jupiter, the period is lengthened for all values of e up to that of ejection from Jupiter's position; (4) where Jupiter's attraction does not change the period of the orbit the periodic orbits have to be found by an adaptation of numerical integration. A. S. D. M.

LIGHT.

515. *The Reflex Origin of Colour Contrast.* **F. Allen.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 375–388, Oct., 1924.)—In this paper the principle of sensory reflex action is applied to the explanation of colour contrast by the method of Ragona Scina. Abney's experiment, in which he found the contrast colour induced on a white surface by green to be orange instead of the complementary purple, is also explained. Consideration is also given to binocular contrast. The theories of contrast of Helmholtz, Edridge-Green, McDougall, Mrs. Ladd-Franklin, Hering and Sherrington are briefly discussed. AUTHOR.

516. *Visual Sensory Reflexes and Colour-Blindness.* **A. Hollenberg.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 389–402, Oct., 1924.)—Section I contains introductory remarks and the consideration of the normal persistency curve of the author in order to determine the character of his type of colour-blindness. Section II contains detailed descriptions of the reflex effects obtained in the right eye by fatiguing the left with colours of various wave-lengths and with white light. The effect of darkness adaptation of the left eye upon colour vision in the right eye is also studied. Section III describes the direct effects of fatigue upon the right eye when colours and white light are used. Darkness adaptation of the right, or observing eye, is also considered. In Section IV various theoretical considerations are discussed, with special reference to the bearing of the curves upon colour theory. It is shown that the absence of reflex effects in the fatigue curves parallels the absence of negative after images in the author's eye. The curves strongly confirm the trichromatic theory of colour vision, and show that in explaining colour-blindness the assumption of a separate white sensation is unnecessary. The cause of colour-blindness seems also to be largely connected with the efferent nerve fibres, the actions of which are shown to be greatly interfered with, or even suppressed, in defective colour vision. AUTHOR.

517. *Binocular Vision and the Stereoscopic Sense.* **R. J. Trump.** (Optical Soc., Trans. 25. 5. pp. 261–270; Disc., 270–272, 1924.)—The convergence of the eyes, the visual focus, and the variation of these accommodations as the eyes sweep over the field do not play any vital part in the appreciation of distance. The recognition of a familiar type of perspective system is important, even to the extent of overriding the evidence of binocular parallax when the two come into conflict. This may be shown by reversing the mounting of stereoscopic photographs or by preparing stereo-diagrams in which the perspective is not in accord with the parallactic displacements. Parallax, powerful in association with other factors, is uncertain, or even breaks down, when not assisted by perspective. There therefore appears to be no "mechanism" of stereoscopic vision dependent upon binocular parallax, but the perception of distance is a psychological function, involving the interpretation of all the details, similarities, and differences in the images in the two eyes, in the light of previous association and experience. AUTHOR.

518. *Ultra-violet Reflecting Power of Some Metals and Sulphides.* **W. W. Coblentz** and **C. W. Hughes.** (Bureau of Standards, Sci. Papers No. 493. pp. 577–585, 1924.)—This paper gives data on the ultra-violet reflecting power of the sulphides of metals (lead, molybdenum, iron and antimony) having a high metallic lustre. The materials examined were the natural minerals—galena, molybdenite, pyrites and stibnite. It is shown that, in contrast with the metals which have a low reflecting power in the ultra-violet and in the visible spectrum, followed by a high reflecting power in the infra-red, the sulphides of these metals have a high selective reflection in the ultra-violet, followed by lower and more uniform reflection in the infra-red spectrum. Data are given also on the reflecting power of graphite, duralumin and magnalium. AUTHORS.

519. *Absorptions in the Ultra-violet.* **G. M. Pool.** (Zeits. f. Physik, 29. 6. pp. 311–314, 1924.)—A method of measurement given; the Schwarzschild law not applied; a monochromator used to prevent false lights; a rotating sector without intermittence-effect used. Method applied to the chlorides of the alkaline earths. A. D.

520. *Absorption Measurements in the Ultra-violet with help of Photographic Photometry.* **H. Ley** and **F. Volbert.** (Zeits. wiss. Phot. 23. pp. 41–51, Sept., 1924.)—The method of V. Henri [see Abstract 1818 (1913)] is adopted in a relatively simple form and is found to give good reproducible values. The use of the Schwarzschild factors, the dependence of which on the blackening, the wave-length, the treatment of the plate, and other factors, in spite of very many theoretical works, is still but incompletely determined, occasions no difficulty for the method. The results obtained are given in tabular form. [See also Abstract 1752 (1924).] A. E. G.

521. *Theory of Diffuse Reflection.* **G. I. Pokrowski.** (Zeits. f. Physik, 30. 1. pp. 66–72, 1924.)—Observations have shown that the intensity of diffusely reflected light does not always depend upon Lambert's cosine law [see Abstract 1117 (1924)]. Light reflected diffusely from a matt surface is composed of two parts: (*a*) That reflected directly from the surface; (*b*) that scattered by the interior of the substance. (*a*) can be found for different angles of reflection by applying Fresnel's formula, and (*b*) by employing the cosine law. Summing the two parts, we get the intensity of the reflected light for different angles of reflection. The author employs this method in testing surfaces of paper (white and coloured), calcined magnesium oxide and lampblack. Good agreement results between the calculated and observed light intensities at all angles for the paper surfaces, but large differences enter for magnesium oxide and lampblack with high angles of reflection. It is shown that this is largely due to the shadowing effect of surface irregularities. The limiting angle at which this effect enters depends upon the size of the reflecting particles, and a correction can be introduced into the expression for the light intensity which results in good agreement being obtained. R. S. R.

522. *Limit of Application of the Law of Refraction.* **P. Fröhlich.** (Ann. d. Physik, 75. 6. pp. 598–608, Nov., 1924.)—A continuation of previous work [see Abstract 107 (1922)] to the case of refraction at surface of glass with various liquids instead of glass-air. J. W. T. W.

523. *Theory of Diffraction by Black Screens.* **F. Kottler.** (Ann. d. Physik, 75. 6. pp. 634–652, Nov., 1924.)—A continuation of previous work [see Abstract 2398 (1923)], with special reference to papers by E. Maey [Abstract 815 (1924)] and A. Rubinowicz [Abstract 2475 (1924)].

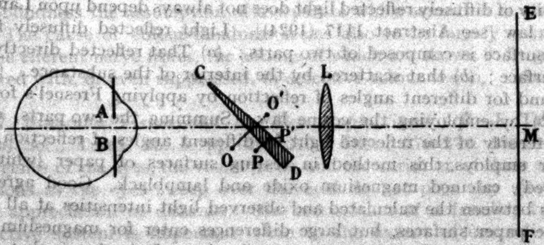
J. W. T. W.

524. *New Measurement of the Velocity of Light.* **A. A. Michelson.** (Frank. Inst., J. 198. pp. 627–628, Nov., 1924. Astrophys. J. 60. pp. 256–261, Nov., 1924. Nature, 114. p. 831, Dec. 6, 1924.)—In the past summer a determination was made between Mt. Wilson and Mt. San Antonio, twenty-two miles away. The accuracy obtained is of the order 1 in 10,000. It is hoped that the work in 1925 will furnish results four or five times more accurate. Below is a table of results of the more important investigations to date, with an estimate of the weight which should be assigned to each:—

Investigator.	Method.	Distance. km.	Weight.	Velocity.
Cornu	Toothed wheel	23	1	299,950
Perrotin	Toothed wheel	12	1	299,900
Michelson	Revolving mirror	0·6	2	299,895
Newcomb	Revolving mirror	6·5	3	299,860
Michelson	Revolving mirror	35·4	3	299,820

E. H. B.

525. *Pupillometer.* **A. Broca.** (Rev. d'Optique, 3. pp. 493–496, Nov., 1924.)—Describes a modification of Fick's pupillometer, so designed that the pupil can be studied under any desired conditions of exposure of the eye to light—*i.e.* any extent or brightness of field. The apparatus is shown in the figure. O, P are two small apertures in an opaque screen, lighted from behind by a lamp. The images O′, P′ of O, P (formed by reflection at the front face of the small-angled prism CD) are seen projected on the field EF. This latter is the field to which the eye is accommodated, and the distance between OP is adjusted until the two discs of light which the images of O, P form on the retina are just touching. Then the diameter of the pupil is equal to OP.



J. W. T. W.

526. *Aberrations of Long Focus Anastigmatic Photographic Objectives.* **A. H. Bennett.** (Bureau of Standards, Sci. Papers, No. 494. pp. 587–640, 1924.)—No lens system gives perfect definition because of the inherent aberrations of spherical refracting surfaces. The aberrations of a centred lens system are defined, and the characteristic manner in which each aberration affects the image is discussed. Methods for the determination of the various aberrations of a photographic objective are described. The Hartmann method, for which a special camera was designed, was used for the measurement of spherical aberration and departure from the sine condition, while a lens-bench method was employed in the measurement of curvature of field, astigmatism, distortion, and lateral and axial chromatism. The aberrations of thirty-three photographic objectives of the anastigmatic type, made by different manufacturers, are presented graphically. The variation among individual lenses from the same manufacturer as well as differences found in lenses of the same construction, but by different manufacturers, are discussed. AUTHOR.

527. *The Taylor-Hobson F/2 Anastigmat.* **H. W. Lee.** (Optical Soc., Trans. 25. 5. pp. 240–247; Disc., 248, 1924.)—An analysis of the aberrations of an anastigmat lens having an aperture of F/2 is given, and comparison made with existing large aperture lenses. Some examples of the performance of the actual lens as manufactured are added, and directions in which the lens should be useful are suggested. AUTHOR.

528. *A Wide-Angle Stereoscope and a Wide-Angle View-Finder.* **L. E. W. van Albada.** (Optical Soc., Trans. 25. 5. pp. 249–258; Disc., 259–260, 1924.)—The paper describes a new type of lens system for use in wide-angle stereophotography and stereoscopy. The system gives a field of view of from 85° to 90° diagonally which is practically free from distortion. The many advantages of wide-angle stereoscopy over the ordinary type are discussed. A new and compact type of wide-angle view-finder is also described, and it is claimed that, with the exception of direct focussing, it yields all the advantages only obtainable hitherto with reflex cameras. AUTHOR.

0 **529.** *The Preparation of Coppered-Glass Mirrors.* **E. A. H. French.** (Optical Soc., Trans. 25. 5. pp. 229–238; Disc., 238–239, 1924.)—The object of this paper is to introduce a method for the deposition of copper on plate-glass surfaces in the form of a highly reflecting coherent film, with special reference to searchlight mirrors. An earlier research on this subject was conducted by Chattaway in 1907, using phenylhydrazine as a reducing agent, but on his findings it was not possible to obtain a coherent copper film on plate-glass surfaces. It is considered by the author of this paper that this was probably due to the formation of tarry by-products, which appear inevitably to result when such a reducing agent is used. A considerable amount of research was conducted at the War Department Searchlight Experimental Establishment with the object of eliminating this drawback, as well as temperature difficulties, insuperable from the use of phenylhydrazine. During this research all possible variations of temperature reduction, quantity and quality of chemicals were explored. This paper presents in detail the results of a few of the principal experiments which were conducted during the necessary research, and fully defines a new method which, by the use of hydrazine sulphate, enables a satisfactory coherent and lasting film to be deposited on plate-glass surfaces at a comparatively low temperature.

As it appears that the cleaning of the glass surface is peculiarly important to the film deposited thereon, a short statement is made as to the cleaning method which was found to be conducive to a satisfactory copper film.
AUTHOR.

530. *The Qualitative Examination and Demonstration of Lens Errors.* **H. Graf.** (Phys. Zeits. 25. pp. 489–495, Oct. 15, 1924.)—A modification of Hartmann's method. Small holes are punched in a metal screen to form a pattern—*e.g.* a logarithmic spiral; the screen is placed close to the lens and perpendicular to the optical axis; a small arc lamp is placed at some distance along the axis; on the other side of the lens is a movable screen of ground glass perpendicular to the axis. If there is no spherical aberration or astigmatism the patterns produced by the beams through the different holes will all be similar to one another, since all the beams pass through the focus of the lens; otherwise the patterns will alter with the distance of the screen from the lens, and a study of the changes gives information as to the lens errors.
H. N. A.

531. *Apparatus for Determining the Magnifying Power of a Microscope.* **E. Judin.** (Phys. Zeits. 25. pp. 495–497, Oct. 15, 1924.)—A small telescopic system is employed, placed above the eyepiece of the microscope, and having unit magnification. A micrometer scale is placed on the stage of the microscope, and a second scale at the common focus of the objective and eyepiece of the telescope, images of both scales being observed through the eyepiece.
H. N. A.

532. *All-round Oblique Illumination in Microscopy.* **E. Mankenberg.** (Zeits. f. Physik, 29. 5. pp. 272–276, 1924.)—The object of all-round oblique illumination is to combine the sharper definition of transparent objects under high-aperture immersions obtainable by oblique illumination with the freedom from azimuthal errors obtainable by central illumination. The conditions are discussed.
A. D.

533. *Reflecting Telescope for Simeis Observatory, Crimea.* (Journ. Sci. Instruments, 1. pp. 1–8, Oct., 1924.)

534. *Slow Speed Precision Training governed from a Distance.* **P. P. Schilovsky.** (Journ. Sci. Instruments, 1. pp. 23–25, Oct., 1924.)—The increase in precision in the training of telescopes, microscopes, etc., is possible only if an electrical device, controlled from a distant station, is applied to the moving parts. It is essential that the angular velocity of the training motor should correspond with that of the handle of the manipulator. Standard motors, in which the speed of rotation depends upon load and output, cannot be used; the only system available is one where the manipulator can revolve the magnetic field of a motor's element in strictest conformity with the speed and direction of a distant device at the governing station. The author gives an explanation of his system of governed motors.
AUTHOR.

535. *Curve Analyser.* **C. F. Sacia.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 487–494, Oct., 1924.)—The wave form of an aperiodic function is reproduced as a fluctuating beam of light whose cross-sectional area varies with time in accordance with the original wave.

Corresponding electric vibrations are derived from the light variations by means of a selenium cell, photoelectric cell, or other suitable device. From these vibrations the various components are selected for measurement, the calibration of the apparatus being taken into account.

G. A. S.

536. *The Spectroheliosco pe.* **G. E. Hale.** (Nat. Acad. Sci., Proc. 10. pp. 361–363, Aug., 1924. Nature, 114. p. 628, Oct. 25, 1924.)—Direct observation of the sun's disc by monochromatic light employing high dispersion is achieved by a modification of the usual spectroheliograph in which the two slits are rapidly oscillated. The image of the sun is formed on the slit of the spectroscope by a cœlostat, and the light then passes to a concave mirror placed to return a parallel beam to a plane grating just below the slit. Thence the diffracted light passes to another concave mirror, which focusses the spectrum below the grating. Part of the spectrum is isolated by another slit. The two slits are mounted on opposite ends of a rapidly oscillating arm, pivoted midway between them, or a series of slits may be cut in a rapidly revolving plate. A. Wh.

537. *Recording Pyrheliometer.* **L. Gorczyński.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 455–464, Oct., 1924. Rev. d'Optique, 3. pp. 473–487, Nov., 1924. Monthly Weather Rev. 52. pp. 299–301, June, 1924.)—A Moll-type thermocouple is combined with a recording millivoltmeter, the couple being clock-driven equatorially. A full description of the thermocouple is given. The elements are in the form of blackened metal strips about 0·005 mm. thick, and the metals used are manganin and constantin. The couple comes to its equilibrium within two seconds, is very sensitive, has a steady zero, and is not unduly delicate. A series of four screens is also described for obtaining the partial intensities of solar radiation. The instrument has been used successfully in the Sahara. A. Wh.

538. *The Theory of Polarisation Prisms. VIII. Prisms of Spar and Glass.* **H. Schulz.** (Zeits. Instrumentenk. 44. pp. 453–457, Oct., 1924.) —Entirely mathematical. [See Abstract 1738 (1921).] E. F.

539. *A Meridian Instrument.* **C. V. Boys.** (Journ. Sci. Instruments, 1. pp. 39–44, Nov., 1924.)—The two images of the sun formed by a pair of plano-convex spectacle lenses, mounted side by side with their optical centres separated by a distance equal to the mean diameter of either sun's image, are observed on a declination time lattice on which the curve showing the equation of time throughout the year is also drawn. A second curve, displaced by an amount corresponding to the longitude, is also drawn, but in colour, on the lattice. An entirely uneducated person may read directly Greenwich mean noon on the coloured curve. Local mean noon may be read on the black curve and local solar time for about twenty minutes before or after true noon may be read on the lattice. With lenses of 64 in. focal length the meridian line may be observed within one second of time, and the overlap of the images in winter and their separation in summer show that the sun is nearer in this hemisphere in winter than in summer. Use is made of symmetry for obtaining a greater accuracy of reading than would be possible with a single image. The larger sunspots may be seen and their transits observed. Equations are given for the calculation of the lines of intersection of cones and radial planes on a transverse cylinder for setting out the lattice, and details of construction are given. AUTHOR.

540. *A Light Filter for the Mercury Line* 2537. **O. Oldenberg.** (Zeits. f. Physik, 29. 6. pp. 328–331, 1924.)—A very short quartz vessel filled with the vapour of chlorine at a high pressure (6·5 atmospheres) is found to make a useful light filter by means of which the portion of the spectrum of the mercury arc-light from 2537 Å.U. up to the extreme photographically active wave-length of the lamp, 4358, is absorbed. It, however, allows the passage of the line 2537. A description is given of the method of carrying out the experiment. A. E. G.

541. *Theory of the Martens Polarimeter.* **J. J. Tichanowsky.** (Phys. Zeits. 25. pp. 482–484, Oct. 1, 1924.)—The essential parts of the polarimeter are a doubly-refracting prism and a nicol. The paper deals with the systematic errors introduced by incorrect setting of the nicol in the neutral position before measurements are to be made. F. S.

542. *Interior Diffusion and True Absorption of Light.* **T. Bialobjeski.** (J. de Physique et le Radium, 5. pp. 269–279, Sept., 1924.)—The theory of true absorption proposed is based on the idea that two phases may be distinguished in the transformation of radiant energy into heat. The first consists in the transformation of regular radiation of waves diffused by reason of the heterogeneity of the medium, whether structural or due to molecular motion. The second phase, referred to as "inferior" diffusion, corresponds with the transformation of the energy of the diffused waves into heat by means of the reaction of the waves on the molecules of the medium. Where the molecules or atoms of the medium are associated with electrons or ions, the latter, by assuming vibratory motion, receive directly the energy of radiation. In a mathematical study it is shown that this conception of absorption can be readily adapted to the quantum theory. A. B. C. L.

543. *Theory of Diffusion of Light in Fluids.* **Y. Rocard.** (J. de Physique et le Radium, 5. pp. 280–288, Sept., 1924.)—It is shown how the molecular theory of diffusion of light is consistent with theories of the Einstein type, and the possibility is established of taking into consistent account the influence of the reciprocal interactions of the molecules of the medium at their respective distances, and consequently the quantity of light diffused by an aggregate of such molecules. A particular force relationship is introduced which is said to have been hitherto neglected, and to be applicable even to highly compressed gases and to liquids approaching the critical state. If θ be the reduced temperature and v the reduced volume of the fluid, all formulæ giving the extent of diffusion by the fluid, on the explicit assumption of random molecular distribution, should be multiplied by $1 + 9H(\theta)/8v$, $H(\theta)$ having the following numerical values, which are applicable to gases, even very compressed, but not to liquids :—

$\theta =$	0·5	0·7	1	1·5	2
$H(\theta) =$	0·530	0·297	0·143	0·079	0·060

A. B. C. L.

544. *Polarisation of Light from the Sky and Sun's Altitude.* **J. J. Tichanowsky.** (Meteorolog. Zeits. 41. pp. 352–357, Nov., 1924.)—Observations were made at Tashkent, 1916–1922, with the help of a Martens polarimeter. The polarimeter support is screwed to a tripod and set accurately in the vertical position. The magnitude of the errors arising from the determination of (1) the plane of polarisation, and (2) the null point of the Nicols, from the movement of the sun during an observation and from the difference of colour of the two parts of the field for comparison in the polarimeter are discussed. Mean values are obtained for the maximum polarisation and for the polarisation at the zenith for altitudes of the sun between -5° and 72°. The maximum value of the polarisation at the zenith was found to occur with an altitude of $-3{\cdot}7^\circ$. For values below -5° the polarisation rapidly decreases, but in no case reaches zero because the light from the night sky is also polarised. A second maximum of polarisation which occurs as the altitude increases beyond $-3{\cdot}7^\circ$ depends upon the magnitude of the polarisation, p, occurring nearer to $0{\cdot}0^\circ$ as p increases. The causes of the decrease of the maximum polarisation with increase of altitude are discussed, and the effects of scattering in the lower air layers, the change of chemical composition with height, and reflection of light from the earth's surface are examined.

R. S. R.

545. *On the Polarisation of Light by Reflection at Diffuse Reflecting Bodies.* **G. P. Woronkoff** and **G. J. Pokrowski.** (Zeits. f. Physik, 30. 2. pp. 139–150, 1924.)—The polarisation of diffusely reflected light has been measured with respect to the incident and reflection angles (i and r), and found to vary directly with the absorption. A maximum is found at $(i + r)/2$, which is dependent on the refractive index. For small absorption no polarisation maximum has been observed. Apparatus details are included with data tables, the amount of polarisation being determined by the König-Marten spectrophotometer for rust, magnesia usta, white, black, and coloured (Rhodamine B, Brilliant Green) papers. A theoretical part prefaces the paper. [See also Abstract 1117 (1924).]

H. H. Ho.

546. *A General Solution of the First Order Aberrational Equations.* **T. Smith.** (Optical Soc., Trans. 25. 5. pp. 273–282, 1923–1924.)—The general equation by which the properties of the component parts of a compound optical system are determined is put into a new form. Solutions are obtained consisting of terms containing arbitrary constants, together with any particular solution. The particular solution itself is the sum of two parts, one of which is independent of the corrections required in the complete instrument, while the other contains only the terms which express these special conditions. The arbitrary terms are given for a system of any number of components, and the particular solutions for systems of few components, the only cases which require special treatment.

AUTHOR.

547. *A Simple Form of Vibration Camera.* **W. H. George.** (Journ. Sci. Instruments, 1. pp. 25–26, Oct., 1924.)—The note describes a simple form of vibration camera suitable for use when photographic records are to be made of either transient or repeated phenomena. A plate-holder taking plates up to 15 cm. long is shot at 300 cm. per sec. or quicker along grooves past a slit in the lid of a long shallow box. Stretched catapult elastic cords or compressed springs, used to give the plate the desired velocity, are arranged so that they just cease to accelerate the plate as the exposure is made. A diagram and the necessary constructional details are given. AUTHOR.

548. *Kinematographic Study on Aeronautics.* **K. Terazawa, K. Yamazaki** and **Y. Akishino.** (Tôkyô Univ. Aeronaut. Research Inst., Report 1. 8. pp. 213–223, Sept., 1924.)—Describes the application of the kinematograph for recording the stream and flow lines about aeronautical models. The drawbacks of the single photograph are discussed, and a description is given of apparatus capable of taking about 1200 pictures per second continuously. Most of the earlier apparatus and records were destroyed in the earthquake and fire of September 1923, but a few pictures were salved, and these form the subject of the present provisional report. The authors used a wind channel of the Göttingen type, and employed the striæ method of Töpler and that of Dvořák; the latter utilises direct projection. Spark photography was used for obtaining the photographs; a high-frequency generator, such as those employed in radio communication, was found satisfactory for obtaining the periodic short-duration sparks. A number of clear photographs are reproduced in the report. A. W. J.

549. *Studies in Photographic Sensitivity. IV. Effect of Oxidisers on the Sensitivity and on the Latent Image.* **S. E. Sheppard, E. P. Wightman** and **A. P. H. Trivelli.** (Eastman Kodak Co. Research Lab. Comm. No. 210. Frank. Inst., J. 198. pp. 507–515, Oct., 1924.)—This paper describes the action of chromic acid on the sensitivity of the latent image, on both ordinary and one-grain-layer plates, and discusses the principal facts determined. Reference is made to the provisional conclusions drawn from this work and to the bearing of the results upon the work of other investigators. The subject of desensitising with copper salts was also investigated. [See Abstract 258 (1924).] A. W. J.

550. *Studies in Photographic Sensitivity. V. Action of Arsenite and Oxidising Agents on the Sensitivity.* **S. E. Sheppard, E. P. Wightman** and **A. P. H. Trivelli.** (Eastman Kodak Co. Research Lab. Comm. No. 211. Frank. Inst., J. 198. pp. 629–646, Nov., 1924.)—The earlier work of Bancroft, Perley and Clark is discussed, and evidence is put forward to show that the idea of pre-exposed sensitive nuclei, due to Clark, was not supported, in so far as his iodometric determinations are concerned, by the published results. The authors advance their reasons for disagreeing with Clark's conclusions and analyse his results in detail. Experiments are described which showed that: (1) For the emulsions tested, even with drastic development of plates treated with any of the arsenates for periods of time ranging from ten seconds to eighty minutes no great developability was produced; (2) the solubility of AgBr grains in the monosodium salt, even in a 10 % concentration and for the longest periods of treatment, was to the eye very slight. There was considerable solubility of the grains in the 10 % arsenites of stronger alkalinity. Tabular values and photomicrographs are included to illustrate the results obtained. A. W. J.

551. *Parallelism of Photographic Blackening Curves.* **W. J. Beekman** and **F. Oudt.** (Zeits. f. Physik, 29. 5. pp. 267–269, 1924.)—The blackening curves for different wave-lengths can be brought to coincidence by a lateral shift with some plates (*e.g.* Wellington orthochromatic anti-screen), but not with others (*e.g.* Ilford panchromatic rapid process backed). There is no general law. A. D.

552. *The Blackening Law with Pigments.* **V. Richter.** (Zeits. wiss. Phot. 23. pp. 61–66, Sept., 1924.)—It is shown that the blackening of pigment gelatine, in the region examined, with the same exposure, is a linear function of the logarithm of the intensity. The straight line part of the blackening curve is many times greater than with a silver bromide gelatine plate. A bending of the blackening curve with over-exposure is generally not observed. The Schwarzschild law is found to hold good for the connection between the blackening and exposure. The exponent in these experiments is found to be 1·24. A. E. G.

553. *Measurements with Martens' Photometer and the Variability of Photographic Blackening.* **K. Schaum.** (Zeits. wiss. Phot. 23. pp. 52–61, Sept., 1924.)—The subject is dealt with under the following heads: Sources of error; most probable error of a blackening measurement; necessity of isotope measurement; temporary alteration of the blackening; influence of swelling conditions. [See also Abstract 2481 (1924).] A. E. G.

554. *Studies in Solarisation.* **Lüppo-Cramer.** (Zeits. f. Physik, 29. 6. pp. 387–391, 1924.)—Although the experiments of Scheffers [see Abstract 832 (1924)] are in themselves very valuable and interesting, his conclusions are arrived at through false reasoning. It is shown in the present paper that his results all find their explanation in the usually accepted theory that the process $AgBr = Ag + Br$ is reversed under very strong illumination in consequence of high bromide pressure; and his coagulation theory is in contradiction with the fundamental fact that halogen-absorbing agencies hinder solarisation. The author refers to his own studies of the reactions of synthetically produced photobromide to prove the correctness of the reversal theory (Das latente Bild, Halle, 1911; Kolloidchemie und Photographie, Dresden, 1921). M. A. E.

555. *The Characteristics of the Phosphorescence of the Rare Earth Elements in Phosphorescent Alkaline Earths. Part II.* **R. Tomaschek.** (Ann. d. Physik, 75. 6. pp. 561–597, Nov., 1924.)—Part I [Abstract 2960 (1924)] dealt with the investigation of the individual characteristics of the phenomena of phosphorescence. The present paper notes the influences of the fundamental constituent materials, firstly those effects which originate from the alkaline earth atoms, and secondly those which have the origin in the common atom. Both these influences evoke variations, on the one hand in the absorption properties, and on the other in the emission. The paper, whilst clearly distinguishing between the two sets of influences, treats of their opposite relationship at the same time. Dealing with the influence of the alkaline earth atoms, the investigation shows that in the case of absorption the effects upon intensity and duration are very great, and under certain circumstances complete inability of illumination results. In all cases where the three alkaline earths were similarly tested it is shown that, with a gradually progressive value of the atomic weight and not a fluctuating one—*e.g.* taking Sr—a maximum and a minimum influence are produced. The temperature conditions are not of great importance as regards intensity. Taking samarium compounds, SrSSm is brighter than CaSSm, and the total illumination is smaller, whilst a yet greater diminution occurs with BaSSm at ordinary room-temperatures. Analagous tests of phosphorescent bodies containing samarium oxide show that BaOSm is not at all bright, SrOSm is medium, whilst CaOSm is the brightest and gives the most lasting illumination. The influence of temperature, and distribution of excitement are discussed fully. When considering the influences on the emission, the investigation is divided under three headings: (1) The displacement of the wave-lengths with alteration of the alkaline earth atoms; (2) the relative intensity of the individual lines to each other; (3) the sharpness of the lines and the influence of temperature thereon. Results of tests made on samarium phosphorescent compounds are appended, as these give excellent definitions of the laws. The common atom phosphorescent effects are similarly treated under the same headings. The characteristics of the groups of lines are investigated, and in general the distribution of lines across the spectrum is irregular, but at individual points crowding or grouping of lines is observed. Such concentration points are known as "partial groups," or "teilgruppen." The most important factor about a particular group is the common excitement distribution which leads to the production of the light emitted from the similar basic nucleus of the different lines. "CaSSm phosphor" was investigated and excited by a monochromatic source from a mercury lamp. The spectrum was duly recorded by a quartz spectrograph, and the ensuing results are embodied in a series of tables. Further investigations on the influence of temperature and the constitution of absorption of phosphorescent bodies were made and the results recorded. After a treatment of the constitution arising from emission nuclei, a strong grasp of the fundamental ideas and observations leads to a conclusive point from which a quantitative estimation of the variation of emission wave-lengths can be made. The variation for the transition from one alkaline earth to another is given as the sum of two expressions, in the first of which the influence of the field external to the nucleus is considered, and in the second the variation of the conditions of combination of the emission electrons are regarded. The relation given shows remarkable agreement with experimental results for phosphorescent manganese compounds. The paper concludes with a detailed discussion of the formula and examples of its validity in experimental work. S. G. B.

556. *Sensitised Fluorescence.* **K. Donat.** (Zeits. f. Physik, 19. 6. pp. 345–355, 1924.)—Experiments are described with a view to testing the theory of Klein and Rosseland on the exchange of energy when atoms of two different gases collide. Mercury was mixed with indium, antimony and arsenic in turn in the gaseous state. Radiation of wave-length 2536·7 Å. was used, and in the case of indium sensitised fluorescence was obtained, but not in the case of the other two elements. J. R.

557. *Derivation of the Planck Radiation Law for Atoms with Two Degrees of Freedom.* **K. F. Niessen.** (Ann. d. Physik, 75. 7. pp. 743–780, Dec., 1924.)—The present mathematical paper seeks to find whether Planck's results will still be obtained when an atom with more than one degree of freedom is considered from the standpoint of the radiation theory. The conclusion is drawn that the Planck radiation law can be derived for the case of two degrees of freedom without the introduction of new hypotheses, and that it is highly probable the case of three can be dealt with in an analogous manner. For more than three degrees of freedom expressions occur which are not easily dealt with mathematically. § 1 reviews the derivation of the Planck law; § 2 considers the application of the disturbance theory; §§ 3–5 give the calculation of special terms; § 6 includes an extension to the case of three degrees of freedom; and § 7 deals with dimensional relationships. H. H. Ho.

558. *Cadmium Radiation from Electrodeless Vacuum Tube.* **M. Hamy.** (Rev. d'Optique, 3. pp. 488–492, Nov., 1924.)—The tubes used have two cylindrical portions in line about 2 cm. diameter, one being about 4 cm. and the other about 7 cm. in length. The two portions are connected by a short neck about 3 mm. diameter. External electrodes about 3·5 cm. in length are mounted symmetrically on either side of the neck; these may be of aluminium foil secured with a binding of soft wire or of plumbago enclosed in brass cylinders. The cadmium is introduced by distillation, and the tube is then sealed up. The tube is heated in an enclosure to a temperature between 295° and 300° C., and an induction coil is used for excitation, the radiation being observed end-on. The apparatus gives three simple radiations, λλ644, 515 and 466, which are capable of giving interferences with path differences of over 20 cm. The radiation λ644 is identical with that given by Michelson's tubes. Three other radiations, λλ538, 534 and 442, will give interferences with path differences of over 4 cm. The other lines observed, λλ632, 509, 480 and 468, are more or less complex. A. W.

559. *Origin of Spectra.* **A. Fowler.** (Roy. Astron. Soc. Canada, J. 18. pp. 373–380, Nov., 1924.)—This paper, which is reproduced from the Handbook to the Exhibition of Pure Science at the British Empire Exhibition, gives a clear statement of the nature of spectral series and their origin according to Bohr's quantum theory. In addition to arc and spark spectra, band spectra and those of highly ionised atoms are dealt with. F. S.

560. *Bands in the Secondary Spectrum of Hydrogen.* **G. H. Dieke.** (K. Akad. Amsterdam, Proc. 27. 7–8. pp. 490–500, 1924.)—Certain groups of lines with constant difference of wave-length have been found by Fulcher, while Croze has arranged lines which have no Zeeman-effect in series. The regularities can be extended from the results of Merton and Barrett. Three groups of bands are found in the red, green and blue respectively. The structure of red band can be plotted as a number of zero branches due to transition $m \rightarrow m$ of the rotational quantum-number m, and the lines satisfy the equation $\nu = A + Cm'^2$ $(m' = 1\cdot 5,\ 2\cdot 5\ \ldots)$. There are also a number of positive branches due to transition in $m + 1 \rightarrow m$. Tables of these branches with intensities are given for all three groups, and the bands discussed from the point of view of Kratzer's theory. F. S.

561. *Continuous Hydrogen Spectrum.* **A. Carst.** (Ann. d. Physik, 75. 6. pp. 665–672, Nov., 1924.)—This was formed when hydrogen or nitrogen canal-rays passed into hydrogen, but not when hydrogen canal-rays passed into nitrogen. The blackening was in both cases the same and agreed with that of the continuous Geissler-tube spectrum. It was difficult, through overlapping of series spectra, to find the true beginning of the continuous spectrum; it lay between H_β and H_γ, with an apparent shift towards longer wave-lengths at higher pressures. It seems certain that the hydrogen molecules are the carriers. This has nothing to do with Bohr's continuous spectrum, which may possibly first appear when the higher members of the Balmer series are excited. A. D.

562. *Term Names of Some Multiplets in the Iron Spectrum.* **S. Goudsmit.** (K. Akad. Amsterdam, Proc. 27. 7–8. pp. 572–583, 1924). —The structure of a multiplet is governed by the restriction-rules for the inner quantum numbers J, which were first used by Sommerfeld, and Landé's relationships between these quantum numbers and the azimuthal quantum numbers K are first briefly discussed in this paper. Using the rules of Sommerfeld and Landé, the values of R, K and J are then determined for the terms which form the iron-multiplets found by Walters [see Abstract 91 (1924)]. It is established that twenty iron-multiplets are combinations of thirteen different terms of a triplet- and a quintet-term system. Copious data tables are included. The multiplet lines are also found to coincide almost totally with the low-temperature lines given by King [Contrib. Mt. Wilson, Vol. VI, p. 351]. Laporte's paper should be consulted [see Abstract 1481 (1924)]. H. H. Ho.

563. *Spectrum Regularities for Scandium and Yttrium.* **W. F. Meggers.** (Washington Acad. Sci., J. 14. pp. 419–430, Nov. 4, 1924.)—Tables are given of examples of multiplets in the arc and spark spectra of both scandium and yttrium. In addition to wave-lengths and wave-numbers of the lines, the energy levels and estimated relative intensities are given, and for scandium King's temperature classes. The results published by Moore for the Zeeman-effect of the yttrium arc and spark spectra are also reproduced, together with the patterns calculated by Landé. Extended results of investigations of the spectra of these two elements are to be published. F. S.

564. *On the Irregularity of the Kα Doublets in Elements of Lower Atomic Number. The Spark Lines of Copper.* **M. Siegbahn** and **B. B. Ray.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 19. [6 pp.], 1924.)—The Kα lines are produced when an electron from the L shell jumps to the K shell, which has previously lost an electron. According to Bohr, the number of electrons in the M shell changes rather suddenly in passing from aluminium to argon, and again in passing from Ti to Cu; these changes affect the next inner or L shell, and the frequency difference of $K\alpha_1$ and $K\alpha_2$ in these regions shows this. Two curves are drawn with $\Delta\nu/(Z-3\cdot5)^4R$, which, according to Sommerfeld's theory, should be nearly constant, and $\Delta\lambda$ as ordinates and Z the atomic numbers as abscissæ. These show that the expected irregularities occur in the above regions. The second part of the paper deals with some new measurements of Dauvillier on the spark lines of copper, in which ten new lines were found in the second order spectrum in the K-series of this element. The authors have now used calcite, which is a more perfect crystal than the rock-salt employed by Dauvillier, and come to the conclusion that some of the new lines of this observer are due to imperfections in the rock-salt employed. In a note on the first part of the paper the authors state that they have made calculations of the gradual changes of the α_1 and α_2 lines from sulphur upwards, and find that from the theory the changes are similar for both the α_1 and α_2 lines. The experiments seem to be strongly in contradiction to the ordinary Sommerfeld relativity theory of the X-ray doublets. H. N. A.

565. *Absorption Spectrum and Constitution of Sulphur Vapour. Predissociation of Molecules.* **V. Henri** and **M. C. Teves.** (Nature, 114, pp. 894–895, Dec. 20, 1924. Comptes Rendus, 179. pp. 1156–1159, Nov. 24, 1924.)—The ultra-violet absorption spectrum has been studied at temperatures between 100° and 1000° and pressures from 0·5 to 53 mm. For $t < 250°$, $p < 10$ mm. only S_8 and S_6 molecules are present, and there is general absorption without structure. Raising the temperature the spectrum of S_2 gradually appears. From 3700 to 2794·2 Å. there are bands with fine structure, and the rotational movement of the molecule is quantified. Details are given of the complicated structure and behaviour of these bands, in which there are more than 5000 fine absorption lines. The moment of rotation for the normal molecule of S_2 is $I_0 = 12\cdot6 \times 10^{-40}$, and for the activated one $I_1 = 13\cdot8 \times 10^{-40}$, as determined from a study of the bands at the lowest pressures at which they appear. The distance between the nuclei of the two S atoms is therefore 0·7 Å. in the normal and 0·73 Å. in the activated molecule. From 2794·2 to 2592 Å. there are narrow continuous bands, without fine structure, the change at 2794·2 being abrupt; this means the disappearance of the quantified rotation of the molecule, and is a special case of a general result described by one of the authors [Abstract 2774 (1924)]. From 2592 to 2475 Å. these are broad continuous bands. The first abrupt change in the structure of the S_2 molecule at 2794·2 Å. corresponds to an increase in the internal energy of 102,100 cal. per gm. mol., causing a decrease of the frequency interval of oscillation of the two S atoms from 397 to 360 cm.$^{-1}$; the distance between the atoms increases so that the bands are weakened; the change at 2592 Å. corresponds to an increase of the internal energy by 110,000 cal. = 4·77 volts; this corresponds to the resonance potential of S vapour, where the valency electrons jump into higher orbits; vibration frequency decreased to 300 cm.$^{-1}$, distance of the atoms further increased. Impacts are no longer elastic at the resonance potential, but it now appears that, before this stage is reached, the internal structure of the molecule is modified, the atoms are driven apart, the bonds are weakened, the molecule becomes more reactive, and the rotational movements are no longer quantified. This is a preliminary preparation for total dissociation, and may be called the predissociation of the normal molecule. Resonance follows, then ionisation, and finally dissociation. H. N. A.

566. *Series Limit Absorption in Sodium Vapour.* **G. R. Harrison.** (Phys. Rev. 24. pp. 466–477, Nov., 1924.)—Transmission curves of sodium vapour for wave-lengths near the principal series limit, 2550 to 2150 Å.—Reliable ultra-violet photometric measurements were secured by using a steady rotating disc cadmium spark as source, and by taking on a single plate, in addition to three absorption spectra, exposures for eight different intensities varied in steps from 2 to 100 by means of oscillating screens, each exposure being for the same time. (The exposure time was reduced to 16 sec. by using an absorption furnace with a column of vapour only 10 cm. long.) Measurements of a single plate thus gave the characteristic curves for that plate which were needed to determine from the absorption spectra the actual transmission as a function of wave-length. As the wave-length decreases, the transmission rises to a maximum at 2465 Å. then decreases regularly to a sharp minimum at the series limit 2414 Å. then rises to a value at 2200, about equal to that at 2465. The series limit absorption thus decreases rapidly with decreasing wave-length. The eighteen curves obtained for different vapour densities are very similar, all being convex upward. The maximum discontinuity observed is from 34 % transmission at 2465 Å. to 20 % at 2414 Å. for vapour of medium density; for greater or less densities of saturated vapour the discontinuity is smaller. Due to the presence of band absorption even beyond the limit, the precise variation of atomic absorption with wave-length cannot as yet be determined from these results. Densitometer curves for sodium principal series absorption and for hydrogen diffuse series absorption in stars show great similarity near the limits. AUTHOR.

567. *Absorption Spectrum and Specific Heat of Chlorine Dioxide.* **H. Mayer.** (Zeits. phys. Chem. 113. pp. 220–234, Nov. 8, 1924.)—Käbitz' 49 bands reduce to five series of 34 members in all. These 34 have $\nu = 20482 + 265 \cdot 5p + 705n - 2 \cdot 9n^2$, p and n being zero or whole numbers. Two oscillations in the molecule; discussed. The specific heat at constant volume is $7 \cdot 5 \pm 0 \cdot 5$ per mol., a figure which shows that there is not a third oscillation in the molecule. A. D.

568. *Regularities in the Arc Spectrum of Cobalt.* **F. M. Walters, Jr.** (Washington Acad. Sci., J. 14. pp. 407–412, Oct. 19, 1924.)—A previous paper [see Abstract 91 (1924)] announced the discovery of regularities in the arc spectrum of iron, which were the first for any element in the eighth column of the periodic table. The alternation law has now been verified for the first member of the triads in this column, since the iron-arc spectrum was found to contain terms of odd maximum multiplicities, and the cobalt-arc spectrum is now shown to consist of combinations of terms whose maximum multiplicities are even. This preliminary note gives twelve multiplets in the quartet system of the arc spectrum of cobalt, which result from the combination of 2 P-, 2 D-, 3 F-, and 1 G-levels, and involve 88 of the 315 lines of cobalt of temperature classes I and II. That the levels F and F′ are the lowest concerned in these multiplets is shown by combinations of the remaining levels with others which involve lines of temperature classes III, IV and V. All the iron terms were found to be inverted, whereas those of cobalt are normal, resembling those of the majority of elements with complex spectra. This abrupt change from iron is of interest, since in approaching iron along a row of the periodic table from the other direction, titanium and vanadium have all terms normal, chromium a few inverted, manganese many, and iron all inverted. The separations of the sub-levels of the quartet system of cobalt average three to four times larger than corresponding separations for the sub-levels of the quintet-system terms in iron. H. H. Ho.

569. *Spark Spectrum of Potassium.* **W. Dahmen.** (Zeits. f. Physik, 29. 5. pp. 264–266, 1924.)—The author presents new measures of spark lines of potassium, photographed with high dispersion and measured at the Physical Institute of Bonn University. The list contains 130 lines between λ3400 A. and λ7000 A. Their analysis into series will form the subject of a future communication. M. A. E.

570. *Theory of the Spark Spectrum of Aluminium.* **F. J. v. Wiśniewski.** (Phys. Zeits. 25. pp. 477–480, Oct. 1, 1924.)—The correction factor to series terms worked out in connection with helium and lithium [see Abstracts 1381 and 2438 (1924)] is now applied to the spectrum of doubly ionised aluminium, Al_{III}, discovered by Paschen. The correction-factor contains a constant which depends upon the constitution of the remainder of the atom, and it is shown in this case to consist of three concentric and singly quantised rings of electrons. The ring nearest the nucleus contains eight electrons, and the second and third one each. This structure differs from that of Kossel and Bohr, but gives better numerical results. The paper is mathematical. F. S.

571. *Arc Spectrum of Sodium.* **F. J. v. Wiśniewski.** (Phys. Zeits. 25. pp. 480–482, Oct. 1, 1924.)—This spectrum is considered in the same way as that of Al_{III} [see preceding Abstract]. The atom is taken to consist of a positive nucleus with two singly-quantised and concentric rings of the electrons, the first containing eight and the second two electrons symmetrically disposed. The ionised neon atom is taken to have the same structure, but with one electron only in the outer ring. This paper also is wholly mathematical. F. S.

572. *The Emission Spectrum of Water-vapour.* **W. W. Watson.** (Astrophys. J. 60. pp. 145–158, Oct., 1924.)—The Origin of the Ultra-violet Band Spectrum of Water-vapour.—New experiments suggest that the carrier of these bands is the hydroxyl ion rather than the water molecule. Furthermore, the application of the quantum theory of band spectra to the fine structure of the λ2811 and λ3064 bands gives information favouring OH as the carrier. Wave-lengths and Series Relations of Lines of the λ2811 Band.—This band has been photographed with high dispersion, and wave-lengths accurate to 0·01 A. have been determined for all its lines. Every line has been assigned to a parabolic series. These series, together with those for the λ3064 band as determined by Heurlinger, have been analysed on the basis of the quantum theory of band spectra. The Moment of Inertia of the Carrier.—The two bands give the same final moment of inertia of $1 \cdot 63 \times 10^{-40}$ gr. cm.^{2}, but different initial moments of inertia. Also the value of the final moment of inertia varies with m, the rotation quantum, while the initial moment of inertia is a constant, independent of the rotational velocity. The relation $R(m) - Q(m) = Q(m-1) - P(m)$, which should hold true for every value of m, is found to be valid only for that m which forms the turning-point of the R branch. New Band at λ3021.—Fifteen new lines extending to the violet from the head of the λ3064 band have been measured. These lines form a single parabolic series. Their carrier is unknown. AUTHOR.

573. *Secondary Electrons emitted by Elements of Low Atomic Weight.* **H. Fricke** and **O. Glasser.** (Zeits. f. Physik, 29. 6. pp. 374–382, 1924.)—Experimental results are given for a series of measurements of the absorption coefficients of secondary electrons emitted from elements of low atomic weight (graphite, N_2H_4CO, $C_2H_2O_4$, NH_4NO_3, $NaNO_3$, magnesium, aluminium, KNO_3, sulphur and copper). The theoretical bearing of the results is discussed and a disagreement with Compton's theory [Abstracts 2194, 2198 (1923)] commented upon. A. B. W.

574. *The Compton and Duane Effects.* **J. A. Becker.** (Nat. Acad. Sci., Proc. 10. pp. 342–346, Aug., 1924.)—Aluminium was used as scatterer for the X-rays, the angle between the incident and scattered beam being about 100°. Under these conditions the Compton shift should amount to 0·027 Å., while the Duane tertiary radiation shift should be 0·069 Å.; for molybdenum the separation α_1 to β is 0·077 Å., and α_1 to α_2 0·004 Å.; it should be readily possible to get both shifts on the same plate for both α and β lines. A calcite crystal was used as a Seemann spectrograph; the aluminium, calcite crystal and photographic plate were screened from all possible stray radiations. Film 2 shows a distinct Compton shift, for both α and β lines, of 0·0275 Å. There is no indication of a Duane shift. Similar results were obtained with film 3, which was placed nearer to the crystal. In film 4 the current in the Coolidge tube was reduced to one-third, while the time of exposure was multiplied by three, other details being the same as with film 3. This shows a faint new line, whose short wave-length edge is displaced from the α peak by just the amount predicted by Duane's theory. It is thought probable that if the intensity could be further reduced the Duane shift would become more pronounced as compared with the Compton shift. H. N. A.

575. *Influence on Secondary X-Ray Spectra of Placing the Tube and Radiator in a Box.* **Alice H. Armstrong, W. Duane** and **W. W. Stifler.** (Nat. Acad. Sci., Proc. 10. pp. 374–379, Sept., 1924.)—A number of experiments recently described on the X-ray spectra produced in secondary radiators of low atomic weight by the K lines of molybdenum show a second set of lines of longer wave-length (several hundredths of an Ångström) in about the same position, whatever the radiator. On the other hand, similar experiments by the author show differences as the radiator is changed. It was thought that the difference might be due to the enclosure of tube and radiator in a lead box with wood present in the case of the former experiments. The opportunity to test this by using such a box and a radiator of sulphur was taken, and it was found that a small subsidiary peak obtained with the box closed disappeared when the box was opened. Considerations of radiological practice suggest that the secondary and tertiary radiation from the inside of the box have sufficient intensity to mask the very weak secondary radiation from the small radiator placed inside the box. F. S.

576. *Influence on Secondary X-Ray Spectra of Placing the Tube and Radiator in a Box.* **S. K. Allison, G. L. Clark** and **W. Duane.** (Nat. Acad. Sci., Proc. 10. pp. 379–384, Sept., 1924.)—Differences between the results obtained by other observers and the authors on the spectra excited in various radiators by certain primary rays suggest a fundamental difference of method. Similar experiments to those mentioned in the preceding abstract are described, but comparison is made between having the tube and radiator in an open room adjacent to that in which the spectrometer was installed and enclosing tube and radiator in a box. Similar results were obtained with the box if the radiator was omitted. F. S.

577. *The Röntgen Spectrum of Multiply Ionised Molybdenum.* **M. Siegbahn and A. Larsson.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 18. [5 pp.], 1924.)—A previous communication (Ark. f. Mat. Astron. och Fysik, 14, 1919) drew attention to the very complex structure of the strongest lines of the L series in the lower elements, special mention being made of the Lα lines of Sn, Ag and Mo. This was also pointed out later by Coster [Abstract 2206 (1922)]. These phenomena are specially evident in the Lα and Lβ lines and in the α and β lines of the M series, as has been shown by Stenström and Hjalmar. An obvious explanation of this complex structure is that on the formation of the Röntgen spectra some atoms undergo a multiple ionisation, and that the resulting transits of electrons correspond to slightly varying wave-lengths of the main lines. These lines then appear as satellites beside the main lines, and thus produce with them the complex structure revealed in the spectra. The description given by several investigators is that beside the main line, on its short-wave side, there is a broad, dark region in which superposed lines are sometimes to be seen. The dark region generally ends abruptly after the short waves. The present researches, however, show that this dark region consists simply of a number of satellites, and its abrupt delimitation is merely a result of their grouping. It is found to disappear entirely when the exciting tension is only just sufficient to generate the L series. In the case of Mo, the exciting tension of this series may be reckoned in round figures at 2900 volts. It is evident from the photometrically registered curves of the Lα line that with 3000 volts only the α_1 and α_2 lines appear, but at 4000 volts a formation of lines begins to be visible on the short-wave side of α_1, and with increased tension these satellites become more prominent, and the majority of them correspond to a state of the atom in which, besides the L group, a higher group (M, N, etc.) has lost at least one electron. The authors consider it as firmly established that the formation of the dark region on the short-wave side of the main lines is due to multiple ionisation of the atoms. The paper gives several curves and a table of the wave-lengths of the satellites.

E. F.

578. *Reflection of X-Rays by Barite.* **S. K. Allison.** (Am. J. Sci. 8. pp. 261–276, Oct., 1924.)—The axial ratios of barite ($BaSo_4$) have been re-measured with an accuracy of 0·02 %, using an X-ray ionisation spectrometer, and the values $a : b : c = 0 \cdot 8148 : 1 : 1 \cdot 3131$ obtained, agreeing closely with the values 0·8152 : 1 : 1·3136 given by Groth. A method has been devised for the detection of the reflections of tilted planes which may enter the ionisation chamber. Data are given covering the spectra obtained from thirteen planes in barite, using a tungsten target tube at 90,000 volts 2–3 m. amps. It is shown that if the unit cell is a rectangular parallelopiped of dimensions 4·449, 5·448, and 7·170 Å.U. containing 2 molecules $BaSO_4$, the units of structure are arranged at the equivalent points of the space group V_h^{13}.

A. B. W.

579. *Refraction of X-Rays in Pyrites.* **B. Davis and R. v. Nardroff.** (Nat. Acad. Sci., Proc. 10. pp. 384–386, Sept., 1924.)—This paper is a continuation of one previously published [see Abstract 1486 (1924)] by the same authors. In the first series of experiments the characteristic K-radiation of molybdenum was used, whereas the present experiments employed the K-radiation of copper to determine the refraction in pyrites.

The refractive effect (see previous paper) depends on the frequency of the incident radiation, in general increasing as the square of the wave-length. The results are included in the following table:—

Radiation.	λ.	δ × 10⁶ (calculated).				δ × 10⁶ (observed).
		$\kappa = 0$.	$\kappa = 1$.	$\kappa = 2$.	$\kappa = 3$.	
Mo $\kappa\alpha_1$	0·7077	3·29	—	3·31	—	3·35 ± 0·20
Mo $\kappa\beta_1$	0·6310	2·62	—	2·64	—	2·87 ± 0·20
Cu $\kappa\alpha_1$	1·537	15·58	16·58	17·6	18·61	17·6 ± 0·5
Cu $\kappa\beta_1$	1·389	12·69	13·12	13·53	13·95	13·2 ± 0·4

The agreement is best for two electrons in the K-ring, thus lending support to the Lorentz dispersion formula for X-radiation. A. B. W.

580. *The Asymmetry of the Electron Discharge produced by X-Rays.* **W. Seitz.** (Phys. Zeits. 25. pp. 546–550, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Refers to a previous investigation of the subject [Abstract 1188 (1924)]. Experiments have been continued along the same lines, using Al, Cu, Ag, Pt and Pb. A field of 50 volts was used to keep back the slow electrons, and it was found that the asymmetry was increased, and to a greater extent for small atomic weights than for large ones; this back field has been increased up to 253 volts, but the curve showing the relation between E_a/E_i and the back voltage was still rising. E_a = electrons emitted in the direction of the X-rays, E_i in the opposite direction. The author has also obtained the magnetic spectrum of the electronic radiation from both sides of a thin metal foil simultaneously, and describes a double camera used for this purpose. The blackening of the plates was measured by Weber with a registering photometer, and the curves obtained are reproduced; they show that the maxima of intensity lie at the same points on both plates, and correspond to equal electronic velocities. The intensity of the slow electrons is decidedly greater on the side where the X-rays enter the foil, which may be due to weakening of the soft X-rays in the foil; the intensity of the fast electrons is distinctly greater on the side from which the X-rays emerge, and this difference increases with the velocity. It is thus not impossible that the Compton electrons are shot out from the atom, only in the exit direction, as Debye's theory requires, for since their velocity is small, they undergo strong diffuse scattering in the metal, and the asymmetry tends to disappear. The experiment makes it certain that the asymmetry is due essentially to the fast photoelectrons, and not, or only to a small extent, to the slower Compton electrons. H. N. A.

581. *Colouration of the Alkali Halides by X-Rays.* **P. L. Bayley.** (Phys. Rev. 24. pp. 495–501, Nov., 1924.)—Colouration of alkali halides and other salts by X-rays.—(1) Hues produced. CsF, RbF, CaF_2, CsCl, RbCl, KCl, NaCl, LiCl, AgCl, BaCl, BeCl, $CaCl_2$, CsBr, RbBr, KBr, KI, NaI, CdI, HgI and K_2SiO_3 were coloured, whereas KF, NaF, LiF, NaBr, RbI, ZnCl, NH_4Cl and about twenty other salts showed no colouration with five hours' exposure to intense radiation. (2) Spectral absorption of coloured halite and sylvite. Halite (NaCl), coloured amber, has a broad absorption band from $0\cdot3\,\mu$ to $1\cdot3\,\mu$ with a maximum at $0\cdot46\,\mu$. Sylvite (KCl), coloured purple, has a similar absorption band with a maximum at $0\cdot55\,\mu$. (3) Spectral fading of coloured alkali chlorides. The colours fade logarithmically when exposed to daylight, the time varying from a few seconds to days. When exposed to the spectrum of a 500-watt Mazda C lamp, coloured NaCl, KCl, RbCl and CsCl, fade most rapidly at wave-lengths $0\cdot51\,\mu$, $0\cdot61\,\mu$, $0\cdot68\,\mu$ and $0\cdot62\,\mu$ respectively. When correction is made for the energy distribution, halite and sylvite are found to fade most rapidly at wave-lengths where their absorption increase due to their colouration is a maximum. AUTHOR.

582. *Index of Refraction of Calcite for X-Rays.* **C. C. Hatley.** (Phys. Rev. 24. pp. 486-494, Nov., 1924.)—Index of refraction of calcite for MoKα_1 rays.—Previous work has indicated that in the case of first order reflection from calcite the bending due to refraction is only 3″. As suggested by Bergen Davis, however, the effect can be greatly increased by using a wedge-shaped crystal with a surface ground and polished so as to make an angle ϕ with the cleavage planes slightly less than the angle of reflection. The first crystal was ground with ϕ equal to $5°\,48\cdot3'$, so that rays which entered at an angle of $12\cdot5°$ with the surface, after first order reflection, left, making an angle of 54′ with the surface. The refraction bending was 29″. A second crystal was ground with $\phi = 6°\,21\cdot5'$, so that the glancing angle was only 21′ and the refraction bending was 64″. The lack of sympathy due to the refraction bending at one surface was determined either by rotating the crystal about a horizontal axis perpendicular to the crystal planes or by using two halves of a split crystal, one ground and the other with natural cleavage, placed one over the other so as to get reflection from each in turn. The mean result is $\mu = 1 - (2\cdot03 \pm 0\cdot1) \times 10^{-6}$. This agrees well with the value given by the Lorentz dispersion formula, $1 - 1\cdot91 \times 10^{-6}$. Wave-length of MoK$\alpha_1$ corrected for refraction.—The correction is 0·017 % for first order reflection by calcite. Special measurements gave the corrected wave-length as 0·70772 Å. (assuming $d = 3\cdot028 \times 10^{-8}$), in good agreement with Duane's value. AUTHOR.

583. *Soft X-Rays and Secondary Electrons.* **J. A. Becker.** (Phys. Rev. 24. pp. 478-485, Nov., 1924.)—Velocity distribution of photo-electrons excited by soft X-rays.—The apparatus was similar to that used in the magnetic analysis of β-rays. Soft X-rays excited by primary electrons with 150 to 1500 volts energy fall on a radiator of W, Pt, Al, etc. The photoelectrons emitted in a plane approximately normal to the uniform magnetic field acting, each travel in a circle with a radius proportional to the speed; those of a given speed which pass through two fixed slits strike a photographic plate, after describing a semi-circle, along a line depending on their speed, thus giving a spectrum. The plates each show a sharp line with a considerable amount of energy right at the $h\nu$ limit, corresponding to the energy of the primary electrons. A band, due to electrons which had lost from 4 to 11 volts in coming out of the radiator, was also observed. These lines and bands indicate that free or loosely bound electrons are more readily rejected than internal electrons by soft X-rays. However, other lines were obtained due to electrons from various levels of the radiator atoms, with energies diminished by amounts corresponding to the critical potentials. Critical potentials obtained by magnetic analysis of photoelectrons.—For *aluminium* radiator: L_2L_3, 70 volts; L_1, 80 volts. For *silver*: N_1, 134 volts; M_3, 365–370 volts. When the target for the primary electrons got covered with tungsten oxide, X-rays corresponding to jumps between N and O levels produced photoelectrons of corresponding energy. In this way the following characteristic lines in the N spectrum of tungsten were observed: N_3O_5, 410; N_2O_4, 482; N_1O_3, 560; N_5O_3, 305; and N_4O_2, 312, all in volts. N_4O_6 is missing, indicating that the O_6 level is not occupied. All the values agree well with the Bohr theory predictions and with other results. AUTHOR.

584. *The Scattering of X-Rays.* **A. H. Compton and Duane.** (Nature, 114. p. 627; Disc., 627–628, Oct. 25, 1924. Paper read before the British Assoc., Toronto, 1924.)—Compton and Debye independently suggested that when a quant "collides" with a free or a loosely bound electron momentum is conserved, and the component in any direction of the momentum gained by the electron is lost by the quant, which therefore corresponds to a smaller frequency after scattering. Thus the change in wave-length of the scattered X-rays will be a function of the angle of scattering; in fact $d\lambda_\theta = h/mc \,.\, (1 - \cos\theta) = 0{\cdot}024(1 - \cos\theta)$, where $d\lambda_\theta$ is the increase in wave-length of the scattered in excess of that of the original beam in the direction θ. Compton has investigated the increase in wave-length of a beam of monochromatic X-rays when scattered at different angles; he finds two scattered beams, one identical with the original beam and one showing exactly the right increase in wave-length. Further, C. T. R. Wilson's cloud-track photographs show electrons with the right energy and direction of motion.

Further confirmation comes from Ross and Bergen Davis, using photographic methods instead of ionisation detection. On the other hand, Duane finds two scattered beams, one of identical wave-length and one of longer wave-length, but the latter he attributes to the photoelectrons ejected from the matter by the primary radiation, which subsequently re-emit softer X-radiation. Duane finds his experimental results bear out his theory. The new wave-length of the Duane-effect will depend on the nature of the scatterer, while the Compton-effect should be independent of the nature of the material. For carbon bombarded with Mo K-radiation the two effects should be nearly the same; these were used by Compton. Neither experimenter could repeat the other's results, so they exchanged apparatus, and each confirmed the other. The only obvious difference was that Compton's tube was shielded with a lead box. Duane tried this with his own apparatus, and found the Compton-effect peak in addition to his own; moreover, the exact portion of the peak depended upon the orientation of the box! *Discussion.*—Ross' experimental arrangements were discussed, and it was contended that the position of his box could not affect his results. **Gray** gave evidence confirmatory of Compton's theory from γ-ray experiments. **Compton** gave an account of an extension of his theory—to include electrons more tightly bound—and showed that the extended theory would embrace Duane's results in the limit. Thus if Compton's theory is verified, conservation of momentum must hold good for quantum collision with electrons; while if Duane is right, only the well-established quantum energy equation need be true. A. C. M.

RADIO-ACTIVITY.

585. *The Action of a Longitudinal Electrical Field on the α-Rays of Radium F.* **W. Hammer** and **H. Pychlau.** (Phys. Zeits. 25. pp. 585–587, Nov. 15, 1924.)—Radium F is deposited on a horizontal copper plate K, and the α-rays pass downward through a protecting wire gauze and through a number of holes in three metal plates, A, B and C, the holes being vertically in line with one another, so that α-rays can pass through to the ionisation chamber at the bottom of the apparatus. Plates B and C are covered with air-tight metal foil, so that the space above B can be evacuated and the pressure of air in the space between B and C, the "brake chamber," can be varied until the rays only just pass for a very small distance into the ionisation chamber. A voltage of ± 21,200 volts was applied to the plate K by means of an influence machine, and the difference of pressure required to obtain a balance was measured; 10,000 volts was found to produce an alteration of 0·0226 cm. in the range of the α-rays. Rutherford's original formula gives an alteration per 10,000 volts of 0·0198 cm.; Geiger's formula gives 0·0226 cm., which agrees with the above result. H. N. A.

586. *Atomic Disintegration.* **H. Pettersson** and **G. Kirsch.** (Phys. Zeits. 25. pp. 588–595, Nov. 15, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Gives a general description of previous work [Abstract 1202 (1924)] and results obtained with newly designed apparatus. The objections of Bates and Rogers are replied to, and it is pointed out that it is possible to distinguish between a scintillation due to an H-particle and one due to an α-particle by an observation of the intensity of the light emitted. By observing at right angles to the direction of the α-particles, and even in a backward direction, it has been shown that carbon, in paraffin, as purest graphite and as powdered diamond, gives off H-particles, which in the perpendicular direction have a range of about 6 cm. Be gives particles with a range of 9 cm. and Si 11 cm. The forward range for Be is 20 cm. and for Si 15 cm. It is remarkable that the lighter element has a larger forward and a smaller perpendicular range than the heavier one, but this result agrees with the authors' explosion hypothesis. Apparently the colliding α-patricles do not recoil backwards, at any rate from aluminium; it looks as if the collision is inelastic and the α-particle may stick to the nucleus. H. N. A.

587. *Decay of Radium E.* **L. Bastings.** (Phil. Mag. 48. pp. 1075–1080, Dec., 1924.)—The same value, $0\cdot139_0 \pm 0\cdot000_1$ day^{-1}, was found for the decay constant of radium E atoms ejecting fast β-particles and of the average radium E atom. The value corresponds to a half-period of $4\cdot98_8$ days. J. S. G. T.

HEAT.

588. *Methods of Measuring Thermal Conductivity in Solids and Liquids.* **L. R. Ingersoll.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 495–501, Oct., 1924.)—A general summary is given of the various methods used to determine conductivity. For solids the four main classes taken are: (1) Linear flow, wall method; (2) linear flow, bar method; (3) radial flow; (4) variable state. The conditions under which each method is used are briefly stated and a full bibliography is given. The methods employed for crystals and liquids are similarly dealt with. R. S. R.

589. *Thermal Expansion of Molybdenum.* **P. Hidnert** and **W. B. Gero.** (Bureau of Standards, Sci. Papers No. 488. pp. 429–444, 1924.)—Expansion tests were made for various temperature ranges between room-temperature and 750° C. on molybdenum ingots prepared from fine and coarse-grained molybdenum powders and on samples swaged to various diameters. The results are presented in figures and tables. Series 1 to 4 (molybdenum samples swaged to various diameters).—Some of the expansion curves on heating show marked changes in the rate of expansion at about 350° C. In most cases the plotted observations on cooling lie above the expansion curves on heating, so that after the expansion tests the specimens were longer than before these tests. For the samples prepared from fine-grained molybdenum powder the average coefficients of expansion between 25 and 500° C. vary from $5 \cdot 4 \times 10^{-6}$ to $5 \cdot 8 \times 10^{-6}$ per degree centigrade, and for the samples prepared from coarse-grained powder the coefficients vary from $4 \cdot 7 \times 10^{-6}$ to $5 \cdot 7 \times 10^{-6}$. Series 5 (swaged and annealed samples).—The annealing was done in hydrogen gas at 1500° C. The coefficients of expansion of the annealed samples of molybdenum are larger than the coefficients of the worked specimens. Several photomicrographs showing the structural changes that occurred in the samples of this series are included. Series 6 (tests at high temperatures).—Forming gas was used for a neutral atmosphere in a high-temperature furnace in two expansion tests on a sample of molybdenum. The annealing incident to the first test had no appreciable effect on the coefficients of expansion of the second test. AUTHORS.

590. *On the Coefficient of Performance of Refrigerating Machines employing Throttle Expansion.* **A. W. Porter.** (Phil. Mag. 48. pp. 1006–1010, Nov., 1924.)—When comparison is made between two cases of mechanical refrigeration, in one of which the cooling is produced by cylinder expansion and in the other by throttle expansion, but in which all else is the same in both, the coefficient of performance is less in the throttle case than in the other. If H_2 is the refrigeration in the cylinder case and W = work of circulation, then the coefficient of performance is H_2/W. The value of the coefficient for the throttle case is $(H_2 - w)/(W + w)$. The author shows how to obtain the exact value of w, which is the increase in the work of circulation in the throttle case. Taking the condenser temperature 70° F. and refrigerator temperature

5° F., he obtains a value of 4·2 for the correct coefficient of performance in the throttle case. The usual calculation would give 5·1; that is, 21 % in excess of the true value. W. C. S. P.

591. *The Production of Cold.* **C. W. Kanolt.** (Optical. Soc. of America, J. and Rev. Sci. Inst. 9. pp. 411–453, Oct., 1924.)—The paper is an exhaustive summary of the methods of producing cold that have found practical application, together with details of methods which have been proposed but never utilised. The principles involved are: (1) Absorption of heat as latent heat, including heat of vaporisation, fusion and solution; (2) cooling of a fluid by doing mechanical work in expansion against a moving mechanism; (3) the Joule-Thomson effect; (4) conversion of heat into kinetic energy of flow; (5) cooling a fluid by doing work of expansion against an electric force; (6) cooling by chemical action; (7) Peltier cooling. These are all dealt with under a variety of headings. Paragraphs are appended on freezing mixtures; the Linde, Claude, and Hampson systems; refrigerating fluids and plants; and notes on liquefaction of hydrogen and other gases. Theoretical considerations are also treated. The latter chapters are both interesting and useful, embodying detailed descriptions and diagrams of valves, joints, and cylinder heads for high-pressure work. The paper is a comprehensive survey of the whole subject. S. G. B.

592. *A Tungsten Furnace for High Temperature.* **W. Fehse.** (Zeits. techn. Physik, 5. 10. pp. 473–475, 1924.)—The furnace consists of a tube of tungsten about 11 cm. long, 1 cm. in external diameter and walls about 0·1 cm. thick. A very heavy current (1080 amps.) at a low voltage (7·4 volts) raises the temperature to 2,700° C. The furnace tube itself is in a water-cooled enclosure, and the enclosure itself may be filled with a reducing or a neutral gas. A. A. D.

593. *A Temperature Indicator Tester.* **D. Lewis.** (Journ. Sci. Instruments, 1. pp. 45–50, Nov., 1924.)—An instrument is described which provides a simple and rapid method of checking the accuracy of temperature indicators or recorders in use with thermocouples. It is shown theoretically that the instrument is electrically equivalent to a thermocouple which can be made to generate any required e.m.f. (in millivolt steps) and to have any required resistance between 1·2 and 12·2 ohms. Details are given of how to use the instrument—(*a*) for checking indicators at one or more points on the scale, so that in a works faulty indicators can be withdrawn from use; and (*b*) for preparing accurate correction curves for indicators, taking into account the increase in resistance of the couple with rise in temperature, so that in a research department indicators may be used in conjunction with calibrated couples to measure temperatures with an accuracy of ± 2° C. AUTHOR.

594. *Superheating of Liquids.* **F. B. Kenrick, C. S. Gilbert** and **K. L. Wismer.** (J. Phys. Chem. 28. pp. 1297–1307, Dec., 1924.)—Experiments by heating the liquids in open capillary tubes at atmospheric pressure and by reducing the pressure on the liquids in closed tubes at constant temperature; temperatures reached, at atmospheric pressure, from 50° to 170° above the boiling-points of the liquids. The initiation of bubbles in freshly drawn capillary tubes appears to be connected with nuclei loosely attached to the walls of the vessels and with a property of the liquid in which there is an element of chance. In freshly drawn capillaries neither dissolved gases in the liquid, nor, apparently, adsorbed gases on the glass, are important factors in initiating bubbles. The radius of bubbles which could exist in equilibrium with the liquids at the highest temperature to which they can be superheated varies from 2·5 to 16 $\mu\mu$. There is a simple relation between the external pressure and the maximum temperature attainable, which holds over a very wide range of pressure. A. D.

595. *Specific Heats of Metals.* **W. U. Behrens** and **C. Drucker.** (Zeits. phys. Chem. 113. pp. 79–110, Oct. 18, 1924.)—A thin metal wire is heated to a constant temperature *in vacuo.* A known amount of electric energy is then passed through it, and the resulting rise in temperature is found by measuring the resistance before and immediately after the heating. The heat losses due to radiation and conduction are estimated from a further resistance measurement a short time after the heating. In a second method a wire at room-temperature is subjected to the same flow of electric energy, and the difference between the two changes of resistance is measured. The knowledge of the temperature coefficient of resistance necessary for calculating the specific heat is obtained by resistance measurements of the wire at different temperatures. The dimensions that the wire should have and other experimental conditions to lead to the greatest sensitiveness and accuracy are discussed. For the true specific heat of drawn zinc are found the following values:—

Temp. °C.	Specific Heat.
5	0·0921
18	0·0927
90	0·0942
120	0·0953
150	0·0963
165	0·0969
180	0·0974
200	0·0983
225	0·0992

Between 0° C. and 225° C. the temperature function shows no anomaly. Hard and soft wires give the same results, and no difference is observed between the specific heats of quickly and slowly cooled wires. G. A. S.

596. *Specific Heats of Metals at High Temperatures.* **K. K. Smith and L. I. Bockstahler.** (Nat. Acad. Sci., Proc. 10. pp. 386–388, Sept., 1924.)—Reference is made to a previous paper (Abstract 1649 (1922)], in which a method is described for the determination of the heat capacity of an incandescent filament. The thermionic current from a hot filament is recorded by means of a suitable oscillograph, the filament being supplied with alternating current of known magnitude and frequency. The amplitude of the cyclic variations of temperature (using a steady temperature calibrate-curve) are employed in the calculation of the heat capacity of the filament and consequently the specific heat at different high temperatures. The mean of a number of determinations of the specific heat of tungsten at temperatures between 2375° K and 2475° K is 0·045 calories per gramme per degree. The atomic heat is therefore 8·3 cals. per gramme atom. A. B. W.

597. *The True Specific Heats of Salt Solutions: Cadmium Iodide, Ammonium Nitrate, and Zinc Sulphate.* **E. Cohen, W. D. Helderman** and **A. L. T. Moesveld.** (K. Akad. Amsterdam, Proc. 27. 7–8. pp. 565–571, 1924.)—Determinations with an accuracy of 0·5 % have been made in an electrical adiabatic calorimeter, and data are now given for the true specific heats of solutions of different concentrations of cadmium iodide (at 19° C.), ammonium nitrate (at 32·3° C.) and zinc sulphate (at 19° C.) Brief details are included. H. H. Ho.

598. *A Spectro-Micropyrometer and the Optical Observation of the Melting-Points of Pt and Other Metals.* **F. Henning** and **W. Heuse.** (Zeits. f. Physik, 29. 3–4. pp. 157–174, 1924.)—The instrument employed is an improvement on the pyrometer used for earlier work [Abstract 2148 (1923)], and it is connected to a spectrometer for use with different wave-lengths. The substances tested are in the form of fine wires for Pt and Pd, and narrow thin strips for Rd and Ir. An optical image of this is produced in the plane of the pyrometer lamp filament, and the image is about twenty times as wide as the lamp filament. The temperature of the substance examined is raised electrically. The pyrometer lamp has been tested and can be used directly for temperatures up to 1200° C. For higher temperatures the luminosity of the glowing metal tested is reduced by inserting successive sheets of smoked glass between the pyrometer lamp and the metal under test. Temperatures up to 2700° C. can thus be examined. For still higher temperatures a magnesium oxide screen is used to reduce further the light intensity. The transparency of the smoked glass is determined by comparison with the action of a rotating sector. The metals tested are brought to within 20° C. of the melting-point, and then the powdering action of the filament decreases its diameter, and with the increased current density the temperature slowly rises to the melting-point.

Assuming $\frac{1}{S_\lambda} = \phi(T') + K\lambda$, where S′ is the black body temperature of the pyrometer lamp, T′ is the true temperature of the pyrometer lamp, and λ is the wave-length, it is possible by pyrometry to calculate S, the black body temperature for any wave-length, thus:—

$$\frac{1}{S_\lambda} = f(i) + (\lambda - \lambda_0)\left(K + \frac{\log D}{c}\right)$$
$$= f(i) + (\lambda - \lambda_0)K'$$

where c is the radiation constant for a black body, i is the current in the pyrometer lamp, D is the transparency of the system between the pyrometer lamp and the metal tested. It is found for Pt that the black body temperature is connected with the wave-length in the form $\frac{1}{S_\lambda} = \frac{1}{2083} + \lambda\,.\,10^{-4}$, and this metal, when melting, radiates over the visible spectrum like a black body at 1810° C. Corresponding figures are obtained for Pd, Rd and Ir. R. S. R.

599. *Determination of Heats of Solutions of Alkali Halides, Diluted and Saturated.* **J. Wüst and E. Lange.** (Zeits. Elektrochem. 30. pp. 523–528, Nov., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—The calorimetric method is that of T. W. Richards as modified by Swientoslawski. The calorimeter is a vacuum jacketed vessel immersed in a water bath. The salts are added in small portions to the water. The intermediate heats of solutions are measured at different concentrations, and the integral heats of solutions are deduced from the observations. All the curves of the potassium salts are similar to one another. The heats of solution and of dilution are negative, but the former become more positive and the latter more negative with increasing concentration; the intermediate solution curves rise continuously. The sodium salts rise to a maximum and descend then; NaI is peculiar. The research is a contribution to the study of the forces in salt crystals according to Kossel, Born and Landé as applied to solutions by Fajans. H. B.

600. *Limits for the Propagation of Flame in Inflammable Gas-Air Mixtures. Part I. Mixtures of Air and One Gas at the Ordinary Temperature and Pressure.* **A. G. White.** (Chem. Soc., J. 125. pp. 2387–2396, Nov., 1924.)—Limits for the propagation of flame in mixtures with air of combustible gases have been determined in glass tubes up to 7·5 cm. in diameter for upward, horizontal, and downward propagation. The gases investigated are carbon monoxide, acetylene, hydrogen, hydrogen sulphide, ethane, pentane, methane, and ethylene. Discrepancies obtained in earlier values are attributed to the following different factors: The use of vessels too narrow to eliminate the effects of wall conduction or too short to give certain information as to whether a given mixture would propagate the flame indefinitely; weak ignition; the use of various directions of propagation; and incomplete mixing or the use of an unsuitable vessel. A distinction is made in the present work between cases in which the flame is only propagated for a short distance and then extinguished and one propagated indefinitely. The lower-limit results showed that the cooling effect of the glass walls appear to be inappreciable in 7·5-cm. tubes. The upper-limit results determined in 7·5-cm. tubes sometimes differ considerably from those determined in 5-cm. tubes—a difference presumably to be ascribed to convection. For acetylene these difference are very large for downward propagation, which is probably connected with the sensitiveness of acetylene to pressure. Tabulated values are given of theoretical flame temperatures calculated from specific heats and heats of combustion. The relation between upper and lower limits and between lower limits and theoretical flame temperatures is considered in the cases of different gases and vapours. [See Abstract 2346 (1922).] J. N. P.

601. *Coefficients of Diffusion of Certain Alkali Salt Vapours in the Bunsen Flame.* **G. E. Davis.** (Phys. Rev. 24. pp. 383–395, Oct., 1924). —The method used is a modification of one suggested by H. A. Wilson (Abstract 1563 (1912)). The ellipsoidal streak of luminous vapour from a salt bead held in the flame was photographed; then the coefficient of diffusion K was obtained from the equation $K = \frac{1}{2}rv(dx/dr - 1)$, where r is the radial distance from the bead to a point on the boundary of the streak, x is the vertical distance of the point above the bead, and v is the velocity of the flames gases. A Meeker gas-burner of special design was used, supplied with air under pressure and with intermittent puffs of salt spray to enable v to be determined. The flame temperature, determined by Féry's method, was 1436° C. The means of about ten determinations of K for each salt are: Lithium chloride, 12·4; lithium sulphate, 9·7; sodium chloride, 19·0; sodium sulphate, 16·4; potassium sulphate, 11·1; rubidium sulphate, 11·7; cæsium sulphate, 8·4. These are probably accurate to about 10%. The chlorides of both Li and Na diffuse faster than sulphates. Except in the case of the lithium salts, for which the observed values are relatively too low, the diffusion coefficients increase roughly as the reciprocals of the square roots of the weights of the metal atoms, also roughly as the reciprocals of the square roots of the molecular weights. If the free-metal atom of the salt is the source of luminosity, as some other experimenters have concluded, it is probable that it is free only a fraction of the time, the fraction varying with the salt and the alkali. AUTHOR.

602. *Use of Koehler Safety Lamp in Testing Tanks for Combustible Gases or Vapours.* **R. E. Wilson** and **R. E. Wilkin.** (Indust. and Engin. Chem. 16. pp. 1154–1156, Nov., 1924.)—As a result of a thorough trial at Whiting, the Koehler safety lamp is recommended as a means of testing tanks and other enclosed spaces for freedom from explosive concentrations of combustible gases. It is simple, safe, and gives reliable indications if directions are followed. It is especially useful in detecting gas pockets in corners, or around outlets, sumps, etc. A series of tests was made to determine the effect of flame height on various concentrations of gasoline in air. If a flame with an initial height of 20 to 25 mm. is used, concentrations of gasoline vapour as low as 0·5% by volume can be detected with certainty. This is from one-third to one-fourth the concentration of the lower explosive limit, but somewhat more than the safe limit for breathing for more than a few minutes. The method recommended for testing tanks with the Koehler lamp for gas is given in detail. AUTHORS.

603. *A Multiple Gas-Analysis Apparatus.* **M. N. J. Dirken.** (Journ. Sci. Instruments, 1. pp. 55–60, Nov., 1924.)—The paper describes a modification of the ordinary type of gas-analysis apparatus, whereby the speed of working is about doubled and the accuracy is the same. A new method of taking gas samples is given and a new sample tube is described. The paper concludes with the description of an analysis and the results of some analyses made with the apparatus. AUTHOR.

604. *Pressure Governors for Controlling the Flow of Gases at High Pressures.* **J. S. G. Thomas.** (Journ. Sci. Instruments, 1. pp. 20–22, Nov., 1924.)—Two forms of governor suitable for maintaining a constant pressure at a point in a gas-flow system under high pressure (up to 100 lbs. per square inch or so) are described. Both forms are of the relief valve type. In the first—the simpler to construct—a gravitational control is employed, whilst in the second the control is exercised by an elastic diaphragm closing a chamber in which a constant pressure is maintained. AUTHOR.

605. *Supersaturation of Gases in Liquids.* **F. B. Kenrick, K. L. Wismer and K. S. Wyatt.** (J. Phys. Chem. 28. pp. 1308–1315, Dec., 1924.)—Experiments with water supersaturated with oxygen, carbon dioxide, and nitrogen. Liquids saturated at concentration corresponding to pressures of over 100 atmospheres, and pressure reduced to 1 atmosphere without bubbles forming in the body of the liquid; and for nearly 100 atmospheres without bubbles forming even on the walls. As in the case of the superheating of liquids there is, with rise of temperature, a very rapid shortening of the time-interval between the lowering of pressure and the formation of bubbles, in spite of the fact that the absorption coefficient of the gas decreases but little with rise of temperature. Colloidal Pt in solution supersaturated with oxygen is favourable to the formation of bubbles, but it rapidly loses its effectiveness. A long heating of the tube containing the solution at a high pressure was found to favour supersaturation. Although CO_2 is nearly thirty times as soluble as oxygen, the average time-interval before bubble formation is about the same for the two gases at the same temperature when the supersaturation corresponds to the same equilibrium-pressure. A. D.

606. *The Thermal Decomposition of Methane.* **R. C. Cantelo.** (J. Phys. Chem. 28. pp. 1036–1048, Oct., 1924.)—The influence of temperature on the equilibrium of the system $C + 2H_2 \rightleftarrows CH_4$ is evaluated by means of the van't Hoff reaction isochore according to which $d \log_e K_p/dT = -H_p/RT^2$, where H_p is the heat of formation of methane at constant pressure and K_p is the equilibrium constant at the temperature T. By integration, allowing for dH/dT from the known change of the specific heats of the components with temperature, and substituting numerical values, the expression is obtained in the form:

$$\text{Const. } T = -18{,}507 + 5{\cdot}9934\,T \log_e T + 0{\cdot}002936T^2 + RT \log_e \frac{pCH_4}{p^2H_2}$$

where 18,507 is the heat of reaction at ordinary temperatures. By means of the equilibrium data determined at 600° C. the value of the constant is found to be 16. It is shown that the equilibrium concentrations derived by Mayer and Altmayer, who determined the constant to be 21·1, are erroneous. According to the present deduction, the percentage of methane present when in equilibrium at 1000° C. is only 0·2 %. The production of carbon as an industrial process by the thermal decomposition of natural gas in the United States is discussed. In order to obtain a soft variety of carbon, it is advocated that decomposition should be effected at a low temperature (*i.e.* 600° – 800° C.), a catalyst being employed to accelerate the breakdown. Of various materials tried as catalysts the best results are obtained with asbestos impregnated with a mixture of nickel and nickel oxide. J. N. P.

607. *A New Phenomenon in the Diamagnetism of Gases.* **A. Glaser.** (Ann. d. Physik, 75. 5. pp. 459–488, Oct., 1924.)—A full account of experiments made by the author on the susceptibility of H_2, N_2, and CO_2 at various pressures, the paper being largely concerned with the experimental detail of the method, a modified Curie balance being used. The method is of such sensitiveness that gases at low pressure may be employed, results being obtained over a range from 0 to 900 mm. of mercury. For all three gases the curve connecting the susceptibility and pressure consists of three parts. Thus the susceptibility of each gas as the pressure is decreased, also decreases approximately proportionally to the pressure. For a given pressure, however, the curve bends, the pressure at which this change appears depending on the gas employed. The susceptibility at lower pressures is higher and approximately three times the value to be expected from an extrapolation of the higher pressure portion of the curve. The curve is, however, again a straight line in the very low pressure parts of the graph. The results are shortly discussed, and it is decided that no certain conclusions can be drawn with respect to the validity of the quantum theory of the effect, though the classical theory, which regards diamagnetism as due to a Larmor precession of the electronic orbits cannot explain the results. The phenomenon is due to the degree of alignment of the molecules in the field, this degree of alignment depending on the relative times taken to turn into this direction and the times between molecular collisions, the ratio between these two times being dependent on the pressures and fields employed. W. V. M.

608. *The Electric Moment of Gaseous Molecules of Halogen Hydrides.* **C. T. Zahn.** (Phys. Rev. 24. pp. 400–417, Oct., 1924.)—An improved heterodyne null method of measurement was used in which the beats between two high-frequency oscillations from separate electron tube generators are adjusted to the frequency of a tuning fork, the small change of capacity due to the introduction of the gas being compensated by a large change in a large capacity in series with the gas condenser. Measurements were made at atmospheric pressure, using carefully purified gases, over a range of nearly 400° from just above the liquefaction point. The results are well represented by the Debye equation $(\epsilon - 1)v\mathrm{T} = \mathrm{AT} + \mathrm{B}$, where v is the specific volume and T the absolute temperature. [The values found for A are 0·001040 (HCl), 0·001212 (HBr) and 0·001856 (HI); and for B are 0·895(HCl), 0·52(HBr) and 0·12(HI).] This agreement lends support to the Debye classical theory of electric polarization due to fixed moments in the molecule. The values obtained for the electric moment of the molecules are, in 10^{-18} c.g.s.u., 1·034(HCl), 0·79(HBr) and 0·38(HI). The Pauli quantum theory gives an equation of the same form as Debye's but leads to smaller values for the electric moment. The upper limit for the moment given by infra-red absorption data for HCl, however, is six times the classical value and thirteen times the quantum value, and hence does not decide between the two theories. Dielectric constant for hydrogen, oxygen, nitrogen and air.—The values obtained for $(\epsilon - 1) \times 10^6$ at 0° C. and 760 mm. pressure are 265, 518, 581 and 572 for H_2, O_2, N_2 and air, accurate probably to within 1/2 %. AUTHOR.

609. *Determination of the Heat Content of Certain Condensed Gases.* **A. Eucken** and **E. Karwat.** (Zeits. phys. Chem. 112. pp. 467–485, Sept. 30, 1924.)—The molal heats of solid and liquid HCl, HBr, HI, NH_3, Cl_2, CH_4 and NO, have been determined from about 25° abs. up to the neighbourhood of the boiling-points under atmospheric pressure, also the heats of fusion and that absorbed at points of change of state. Euckens vacuum calorimeter was employed, energy being supplied to the substance *in vacuo* by means of a current sent through a resistance coil wrapped round the containing vessel, and the temperature measured by determining the resistance of a lead or platinum coil. The results are given in a series of tables which include the values of C_p, of θ_M and K in Lindemann's melting-point foumula $\theta_M = K\sqrt{T_S/MV_M^{2/3}}$, of J the heat content and of the double integral $\Phi = \int_0^T dT/T^2 \int_0^T C_p dT$. The sums of the heats of change of state of the three halogen hydrogen compounds are not very different from one another, and the mean of the temperatures at which the change take places is nearly the same for all of them. Apparently at low temperatures, where the molecule may be expected to vibrate as a whole without interatomic vibrations, the results for HCl, HBr, NH_3 and NO can be represented by a simple Debye function. In other condensed gases the interatomic vibrations appear to have greater importance, and it is hoped that interesting conclusions as to certain peculiarities in the forces acting between the atoms may be arrived at, by study of the molal heats at low temperature.

H. N. A.

610. *The Vapour Pressure of Solid Hydrogen Chloride, Methane and Ammonia.* **E. Karwat.** (Zeits. phys. Chem. 112. pp. 486–490, Sept. 30, 1924.)—Tables are given showing the observed vapour pressures for absolute temperatures from 122·74° to 159·34° for HCl, from 76·89° to 87·25° for CH_4 and from 162·39° to 193·45° for NH_4. The values agree for HCl, from 120° to 159°, with the equation $\log p = -(1171\cdot62/T) - 2\cdot3577 \log T + 14\cdot57497$, for CH_4, from 75° to 90·5°, with $\log p = -(550\cdot621/T) - 1\cdot0831 \log T + 10\cdot14005$ and for ammonia, from 100° to 195°, with $\log p = -(1790\cdot00/T) - 1\cdot81630 \log T + 14\cdot97593$. For the triple point, using Henning's vapour pressure equation for the liquid region, the values $T_s = 159\cdot55$, $p = 104\cdot19$ mm. are calculated for HCl, the vapour pressure observations (solid) give $T_s = 159\cdot35$ and $p = 103\cdot44$ mm.; calorimetrically the value $T_s = 159\cdot0°$ was obtained by Eucken and the author [see preceding Abstract]. With methane the Henning equation gives $T_s = 90\cdot48°$, while the calorimetric measurement gave 90·5°, the heat of fusion, however, comes out as 212 cal., which is smaller than the calorimetric value 232·0 cal. The difference may be due to impurity in the methane used by the author and Eucken, the pressures having been lowered 0·2 mm. by the presence of a less condensible gas; this would make the vapour pressure equation $\log p = -(554\cdot518/T) - 1\cdot0831 \log T + 10\cdot1840$, the calculated melting-point 90·2°, and the calculated heat of fusion 230 cal. For ammonia, using the vapour pressure equation of the solid and Henning's equation for the liquid, the heat of fusion 1422 cal. is obtained, measured value 1427 cal. Melting-point calculated as 195·24°, Brill's value 195·4°, calorimetrical determination 195·5′.

H. N. A.

611. *Theory of Gas and Equation of State.* **J. Duclaux.** (J. de Physique et le Radium, 5. pp. 331–337, Nov., 1924.)—A mathematical treatment which sets out with the assumptions that there are no appreciable attractions and that the molecules are either completely independent or chemically combined. Thus are found the formula of van der Waals and the more exact one of A. Leduc. Monatomic gases and corresponding states are also treated.

E. H. B.

612. *The Calculation of Gaseous Equilibrium Constants.* **S. W. Saunders.** (J. Phys. Chem. 28. pp. 1151–1166, Nov., 1924.)—This paper analyses the existing data on the molecular heats of gases, heats of reaction, chemical and equilibrium constants for well-known reactions involving carbon, hydrogen, oxygen and nitrogen. Values for the mean molecular heats of gases at constant pressure, between 0° K. and T° K., obtained from experimental values for the mean molecular heats between 273° K. and T° K., by extrapolation to 0° K., have then been used, together with the Nernst conventional chemical constants and the heat of reaction at room temperature, for the calculation of equilibrium constants. The assumptions made and the empirical nature of the equations obtained are fully realised, but except for the reaction resulting in the synthesis of ammonia, where the Nernst assumption with regard to the molecular heats was made, the equations obtained agree with experimental results. The conclusions reached should be of practical value for the study of the gas reactions occurring in producer and coal-gas manufacture, in the detonation of high explosives, etc. H. H. Ho.

613. *Pressure Equations for Liquid and Vapour Mixtures and their Application to Air.* **V. Fischer.** (Zeits. techn. Physik, 5. 10. pp. 458–468, 1924.)—Mathematical treatment of these thermodynamic problems illustrated by three diagrams each exhibiting a number of graphs. E. H. B.

614. *Influence of Thin Surface Films on the Evaporation of Water.* **G. Hedestrand.** (Phys. Rev. 28. pp. 1245–1252, Dec., 1924.)—A current of dry air of known speed and volume is led, under standardised conditions, over an evaporation surface of pure water, and of water covered with oil films of various fatty acids. Experiments are also carried out with solutions of saponin and of KCl. In each case the water evaporated is collected and estimated. The oil films employed are of the character of the monomolecular films studied by Rayleigh, Adam and others [see Abstracts 280 (1922); 6 and 390 (1923)], under varying conditions of "compression." The results indicate that the decrease in the rate of evaporation of water, caused by a unimolecular film of fatty acids, is very small, if any at all. This favours the conception that the relation between the water molecules in the surface and the oil molecules is a very intimate one. The oil film cannot be regarded merely as a thin layer of oil floating on the water, though in many respects it behaves as if it were so, but the oil molecules must be considered as adsorbed, that is, according to Langmuir, chemically bound by the electric stray fields of the surface molecules and partly "dissolved" in the water. They are, therefore, forced to follow the thermal agitation of the water molecules, the result of which is a definite evaporation. Thus an oil film does not oppose any considerable "resistance" to the escaping water molecules and the rate of evaporation is not diminished. The same reasoning can be applied to the case of a surface film formed by the adsorption of a substance in solution. A. B. C. L.

615. *Condensation and Re-Evaporation of Activated Hydrogen.* **F. Paneth.** (Zeits. Elektrochem. 30. pp. 504–508, Nov., 1924. Paper read before the Deut. Bunsen Gesell, Göttingen, 1924.)—Three forms of activated hydrogen are supposed to exist: atomic (near incandescent wires and in electric discharge, Langmuir); the H_3 of J. J. Thomson;

another H_3, obtained by Duane and Wendt by α-ray bombardment [Abstract 1728 (1922)], and studied as to its reactivity by them and by Venkataramaiah. The author describes experiments made by himself and K. Peters to improve the very small yields of activated hydrogen by rapid cooling of the hydrogen with liquid air immediately after the activation and passing it over dry sulphur which should then liberate H_2S. In the first experiments the hydrogen was passed over Nernst glowers, which became brittle and burnt through in a few moments owing to reduction. In the second series the hydrogen was passed through an electrically-heated palladium capillary. A slight activation was observed in both cases. H. B.

616. *On the Thermodynamics of the Capillary Layer.* **G. Bakker.** (Ann. d. Physik, 75. 7. pp. 685–710, Dec., 1924.)—This mathematical paper deals in § 1 with the formation of the capillary layer considered as two stages, *viz.*: (1) The homogeneous phases of liquid and vapour placed together. (2) The influence of each on the surface of contact bringing about the stable phase of the capillary layer. If ρ_1, ρ_2 be the densities, and ϵ_1, ϵ_2 the energies of liquid and vapour respectively, ϵ the energy of the capillary layer, and r_i the internal heat of evaporation, then the energy transformation of (1) is given by $(\rho_1 - \rho_2)r_i/2(\rho_1 + \rho_2)$, and of (2) by $\epsilon - (\epsilon_1 + \epsilon_2)/2$. After a discussion of the energy relations the expression,

$$(\mathrm{H} - \mathrm{T}d\mathrm{H}/dt)\rho = \epsilon - (\epsilon_1 + \epsilon_2)/2 + (\rho_1 - \rho_2)r_1/2(\rho_1 + \rho_2)$$

is derived, where H is the capillary constant and S the surface of the capillary layer. In § 2 it is shown that the differential of this expression can be put in the form

$$d\epsilon - \mathrm{T}d\eta + p_\mathrm{T}dv = \mathrm{H}v\{\partial s/v/\partial t - \partial w/v/\mathrm{R}\partial t\}dt,$$

where w is an abbreviation for $2v_1v_2/(v_2 - v_1) - v(v_1 + v_2)/(v_1 - v_2)$, η is the entropy, p_T the average pressure along the capillary layer, R the radius of curvature, and v the volume per unit mass of the capillary layer. For isothermal changes $\mathrm{T}d\eta = d\epsilon + p_\mathrm{T}dv$, where p_T becomes the work factor of the isothermal external work. In § 3 a calculation is made of the thickness of the capillary layer of two drops of liquid and of a vapour bubble of carbon dioxide. Here theory and experiment are in fair agreement. If R_1 and R_2 be the internal and external radii of the boundary surfaces of the capillary layer, then for practical purposes $\mathrm{R} = (\mathrm{R}_1 + \mathrm{R}_2)/2$, and serves as the radius of the capillary layer.

H. H. Ho.

617. *The Physical Basis of the So-called Reciprocal Theorem.* **H. Hausen.** (Zeits. f. Physik, 30. 4–5. pp. 280–284, 1924.)—This paper contains a detailed examination of the physical basis of Jazyna's reciprocal theorem in reply to a recent paper by him [see Abstract 3005 (1924)] and demonstrates the faulty character of his physical conclusions, *viz.*: (1) That, according to the second law of thermodynamics for those states for which $C_p < 0$, C_v must be negative; (2) the negative value of C_v is physically improbable. H. H. Ho.

618. *Thermal Equilibrium in the Atmosphere.* **C. G. Rossby.** (Ark. f. Mat. Astron. och Fysik, Stockholm, 18. 20. [8 pp.], 1924.)—In the first place an adiabatic cylinder is assumed, of height h, filled with σ ideal gases with given energy and mass; then if U is the energy and S the entropy $\delta V = 0$ and $\delta S = 0$. Planck's expressions for the entropy is made use of, and also his equation of state, and by eliminating p the pressure between these equations a new expression is obtained for S. It is shown that $\delta(S + U/\theta) = 0$ where θ is the constant absolute temperature, and it finally appears that the distribution follows Dalton's law. The second part of the paper deals with a given distribution of temperature. The temperature field, which is really due to radiation, is supposed to be produced by dividing the atmospheric column into a number of thin layers by a large number of horizontal partitions; each layer is connected to a source of heat of infinite capacity and of suitable temperature. A variation is now supposed to take place in the column, and expressions are given for the alterations of the entropy and the number of gramme molecules of each gas in unit volume at height x; the necessary energy is taken from the heat sources, expressions for the alterations of whose entropies are given; finally, expressions for the partial pressures and for the total pressure are obtained by taking the total alteration of entropy as zero; that for the partial pressure is the same as that derived from the fundamental hydrostatic equation and the law of gases for a chemically homogeneous atmosphere, and is a generalisation of Dalton's law. H. N. A.

619. *Remarks on the Paper "The Inapplicability of the Equipartition of Energy in a System Comprising Vibrating or Rotating Particles," by J. Jaffé.* **R. Becker.** (Ann. d. Physik, 75. 5. pp. 556–560, Oct., 1924.)—Deals with the statement [see Abstract 2897 (1924)] that when the natural frequency ν of the elastically bound atoms increases—*i.e.* when the rigidity increases—the mean energy content, if they are in thermal equilibrium with an ideal gas of given temperature, remains the same, while in the case of absolute rigidity the energy content drops in a discontinuous manner to zero. The difficulty is due to the fact that the time taken in attaining thermal equilibrium between the two sets of particles becomes very large as the rigidity increases. If a gramme atom of gas at T_0 is allowed to pass into a flask, containing a solid with energy content zero, classic statistical mechanics gives the final gas temperature as $T = T_0 \times 1 \cdot 5R/(1 \cdot 5R + 3R)$ independently of ν. The time that elapses before this temperature is reached can be increased to any extent by increasing ν, and as it may amount to thousands of years' experimental verification is impossible. It seems clear that the observed values of the specific heats of certain solid bodies, which are larger than 3R, are not to be explained in this way; they must be regarded as upsetting the mechanical assumptions which form the basis of the classical statistical mechanics. H. N. A.

620. *Thermal Radiation from the Standpoint of Industrial Application.* **C. Roszak and M. Véron.** (Rev. de Mét. 21. pp. 435–449, Aug.; 549–564, Sept., and pp. 600–609, Oct., 1924).—The importance of thermal radiation for hearths, ovens, etc., renders its exact determination very necessary, but unfortunately the application of the radiation laws is a matter of considerable difficulty. Data have hitherto been based on Péclet's formula, deduced from the work of Dulong and Petit, which, however, is only valid as far as 300°, so that an exaggerated extrapolation

has been involved. The present paper revises the subject from the standpoint of data now available up to 1700° and with respect to more recent discoveries concerning thermal exchange. A very full general discussion of radiation is given in Part I, and the practical principles to be employed are then deduced. Following this come a calculation for boilers, etc. Part II is entirely devoted to a mathematical investigation of the formula $S\mu_m$, which represents the product of the area of the radiating surface and the ratio of the angles relative to the radiated surface viewed from the radiating surface. The calculation is simple when both surfaces are plane, but such is exceptional, and various methods for other cases are discussed, including approximate, graphical, and rigid. Part III deals with practical applications, and contains investigations of isolated radiation, polished surfaces, radiation combined with or compared to convection, preheaters, domestic heating, and pyrometry. The three parts are mostly mathematical and should be consulted in their entirety.
H. H. Ho.

621. *Scientific Principles of Artificial Incubation.* **L. B. Atkinson.** (Roy. Soc. Arts, J. 73. pp. 37–55, Nov. 28, 1924.)—The paper is the result of tests carried out by the author during fifteen years. Ancient methods still employed in China and Egypt are described and it is shown that these crude methods give better results than modern incubators. The Chinese method gives 95 to 98 % of fertile eggs hatched, the Egyptian method 85 to 90 %. Modern incubators are described and the physical and chemical laws operating are given in simple terms. The low thermal efficiency of existing plant is emphasised. It is shown that in incubators of the "hot air" type the amount of air passing does not depend on the size of the openings or ventilation outlets but only on the rate at which heat is lost from the walls of the incubator and on the temperature in the heater chimney. This is a reason why this type is not suitable. The biological processes in the egg during incubation are described and it is shown that during the twenty-one days the requirements as to humidity and carbonic acid contents should be varied. The amount of ventilation which decides the concentration of carbonic acid, and humidity, are all-important factors. Successful methods of demonstrating these by the change of colour of paper moistened with chemical salts are given. Generally all types of incubators are found by the author to suffer from too much air and from too low a concentration of carbonic acid at the earlier stages and the air is too dry. Results of tests of the actual conditions under the hen during hatching are given, from which it is deduced that 50 % humidity is the safest factor to aim at. The author has found that the egg under the hen is about 14° F. cooler at the bottom than at the top. This difference of temperature is of the greatest importance, and he has reproduced it artificially by covering the upper surface of the eggs with a very thin sheet of indiarubber. The downward stream of hot air passes over the rubber, raising the temperature of this to 105° F., while the temperature at the bottom remains at about 91° F.; the rubber further prevents evaporation from being too rapid. An incubator which had rarely given above 55 % hatchings gave about 95 % of the fertile eggs and about 89 % of all the eggs placed in it after this modification had been carried out.
R. O. K.

SOUND.

622. *Sensitiveness of the Ear for Compound Tones.* **H. Barkhausen** and **G. Lewicki.** (Phys. Zeits. 25. pp. 537–541, Nov. 1, 1924. Paper read before the Deut. Naturforscher. u. Ärzte, Innsbruck, 1924.)—The concordant result of these experiments is that the audibility of a compound tone is simply equal to that of its subjectivity loudest sine-form overtone. This rule suffers a slight modification if the loudest tone is higher than the fifth overtone. E. H. B.

623. *Speed of Sound and Ratio of Specific Heats for Organic Liquids.* **W. Busse.** (Ann. d. Physik, 75. 6. pp. 657–664, Nov., 1924.)—Following the method of K. Doersing [Abstract 432 (1908)], which gives sharp nodes, the author has dealt with a number of organic liquids and obtained the results shown in the accompanying table.

Substance.	Formula.	Speed of Sound.	Ratio of Specific Heats.	Temp. of Experiments.
		m./sec.		°C.
n. Hexane	C_6H_{14}	1111·7	1·313	21·0
Nitromethane	$CH_3 - NO_2$	1360·5	1·459	21·0
Methylalcohol	$CH_3 - OH$	1143·2	1·240	19·0
Amylalcohol	$C_5H_{11} - OH$	1269·8	1·183	20·0
Acetone	C_3H_6O	1189·4	1·341	20·5
Paraldehyde	$C_6H_{12}O_3$	1202·4	1·301	21·5
Chlorbenzole	C_6H_5Cl	1315·4	1·347	17·0
Nitrobenzole	$C_6H_5 - NO_2$	1506·1	1·266	17·5
Aniline	$C_6H_5 - NH_2$	1675·7	1·279	20·8
Ethylbenzole	$C_6H_5 - (CH_3)_2$	1351·0	1·309	20·0
Toluol	$C_6H_5 - CH_3$	1327·2	1·378	20·5
o. Nitrotoluol	$C_6H_4(NO_2) - CH_3$	1482·0	1·275	20·5
o. Toluidine	$C_6H_4(NH_2) - CH_3$	1644·8	1·213	21·0
m. Toluidine	$C_6H_4(NH_2) - CH_3$	1602·4	1·197	21·6
m. Cresol	$C_6H_4(OH) - CH_3$	1492·5	1·145	21·5

E. H. B.

624. *Accurate Determinations of the Speed of Sound in Sea-Water.* **E. A. Eckhardt.** (Phys. Rev. 24. pp. 452–455, Oct., 1924.)—Sound and radio signals were transmitted simultaneously to receiving apparatus at a distance of over 60 miles. The distances were determined to within 6 ft. and the times to within 0·001 sec. so that the mean of 8 independent values obtained within 10 minutes is accurate to about 1 in 50,000. With practically no tide, the mean result was 4896·1 ft./sec. or 1492·3 m./sec. The method is sufficiently accurate to determine the variation in the speed of sound with temperature or salinity or to measure the component of tidal flow parallel to the sound path. The practical limitations imposed on distance determinations by the use of sound signals in sea-water are thus determinable. AUTHOR.

625. *Maintenance of Vibrations of a Free Reed.* **Z. Carrière.** (J. de Physique et le Radium, 5. pp. 338–344, Nov., 1924.)—The problem to be solved was whence comes the energy which maintains the vibrations of a free reed, the wind chest or the resonator. By an elaborate experimental arrangement it was found that the wind chest so far from providing the energy to the reed borrowed from it. The energy was provided by the resonator alone. E. H. B.

626. *On the Partials of a Pianoforte String Struck by an Elastic Hammer.* **R. N. Ghosh.** (Phys. Rev. 24. pp. 456–460, Oct., 1924.)—Neglecting small terms in the partial differential equation of motion, a solution is obtained involving the mass, elasticity and impact speed of the hammer and the distance of impact a from the nearer fixed end. Also approximate expressions are obtained for the pressure exerted on the string and for the duration of impact. The final solution for the displacement contains besides the Helmholtz term, three others. For a given a, the Helmholtz term disappears for partials with periods 2, 2/3, 2/5, etc., but not the other terms; this explains the observed existence of these partials with feeble intensity. The equation shows how the relative strengths of the partials depend on the various factors. If the duration of impact is half the period of vibration of a component, that component will become very prominent. For a given velocity of impact, the resulting amplitude increases with a. AUTHOR.

627. *Organ Pipes of Unusual Shapes.* **W. E. Benton.** (Nature, 114. pp. 573–574, Oct. 18, 1924.)—The paper of J. A. Aldis [see Abstract 170 (1925)] on the Bicylindron is not only of practical importance to the scientific pipe-builder, but also constitutes an important addition to the acoustical theory of the organ or pipe. The Aldis Bicylindron is new to organ-practice, but there has existed for several hundred years a form of pipe, the theory of which is similar to that of the Bicylindron, although differing greatly in its solution. This is the Rohrflöte, or Flûte à Cheminée (a particular case of which is found also in the Flauto d'Amore), the invention of which may be claimed by the German organ-builders of the seventeenth century. It was found that a stopped pipe of medium scale could be given a very beautiful smoothness of tone if the stopper were perforated by a narrow cylindrical hole, coaxial with the pipe. In old German organs the four-foot stopped diapason in wood was sometimes treated in this way, thereby replacing the rather nasal stopped diapason quality by one more desirable in a small organ. Later, the perforation was extended to metal pipes, a particular stop known as the Rohrflöte being constructed, which owed its peculiar ringing quality to the extension of the main body of the pipe in a short, narrow "chimney," and to the provision of a semicircular mouth with large ears, which enable the pipe to be tuned exactly. The theory of the Rohrflöte was mathematically established by R. Gerhardt in 1884. (*Nova Acta der Kgl. Leop.-Carol-Deutschen Akad. der Naturforscher,* Band 47, 1. Halle, 1884.) Since his treatise is inaccessible to the present author, he here attempts an investigation, hoping that any one having access to the original will call attention to any variations between the two solutions should such exist. The Rohrflöte is obviously a Bicylindron of which both pipes are open, and the one of larger diameter contains the mouth. The solution is, therefore, markedly different from that of J. A. Aldis. But in both cases the displacement is discontinuous at the plane joining the two tubes, although the differential coefficient of the displacement, with respect to measurement along the axis of the pipe, is continuous at that plane. Using the same treatment as that used for the Bicylindron, the solution for the Rohrflöte is

$$\frac{\tan mh}{\tan mk} = -\frac{r^2}{R^2},$$

where $m = 2\pi/\lambda$, λ being the wave-length of the resultant fundamental vibration, and h and k the speaking lengths, and r and R the radii of cross-section of the chimney and body respectively. If $\tan (mh) = \tan (\pi/n)$, a series of partials will be obtained, in certain cases, given by

$$1, n-1, n+1, 2n-1, 2n+1, \ldots \text{ etc.}$$

Even if n is not an integer, and the upper partials consequently inharmonic, the difference tones will give the octave of the fundamental, and hence the effect may not be altogether unpleasing. Further consequences of the theory are developed. E. H. B.

628. *Organ Pipes of Unusual Shapes.* **W. E. Benton.** (Nature, 114. pp. 787–788, Nov. 29, 1924.)—Through the kindness of W. B. Morton, the author has now been enabled to examine R. Gerhardt's original inaugural dissertation on the Rohrflöte, delivered in Halle in 1884. It is found that Gerhardt's equation for the case of a pipe with a closed chimney is identical with that by J. A. Aldis for the Bicylindron, and for the Rohrflöte proper with open chimney his equation is the same as that of the present author [see preceding Abstract]. Gerhardt discovered a little of the history of this interesting pipe register. The Rohrflöte is apparently of considerable antiquity. Prætorius mentioned it in his *Syntagma Musicum*, 1619, and the pipe was probably invented in the middle of the sixteenth century. The present author also calls attention to the very thorough treatment of pipes with sudden changes of diameter given by P. Cermak [see Abstract 182 (1918)]. E. H. B.

629. *An Electrical Stethoscope.* **H. A. Frederick** and **H. F. Dodge.** (Bell System Techn. J. 3. pp. 531–549, Oct., 1924.)—The vibrating part of an electromagnetic transmitter is placed in contact with the patient. The electric reproductions of the sounds pass through a three-stage amplifier with control and a group of electric filters to a single receiver or to a number of receivers if necessary. Analyses of about 100 hospital cases of heart murmurs, râles, and breathing sounds, show that sounds of pathological interest to the physician can be grouped into fairly definite frequency regions. The cut-off frequencies of the filters are arranged to pass such sounds and to eliminate the usual interfering noises. Sounds much too faint to be heard with an ordinary stethoscope by any but a trained observer are easily audible with this instrument by any number of inexperienced persons simultaneously. By selective use of the filters any particular frequency region can be magnified. Photographic and phonographic records are conveniently made. G. A. S.

630. *Acoustic Filters in Series.* **G. W. Stewart.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 583–585, Nov., 1924.)—Owing to the resonance of the different sections of the transmitting conduit there are always "additional transmission bands" with acoustic filters. By suitable combination in series of two filters having unlike additional bands it is possible to eliminate defects of the single filter. G. A. S.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS, AND ATMOSPHERIC ELECTRICITY.

631. *C. Hering's Demand for Revision of Electromagnetic Laws.* **A. Liénard.** (Rev. Gén. d'Él. 16. pp. 811–819, Nov. 22, and pp. 851–859, Nov. 29, 1924.)—Recent articles by C. Hering [see Abstracts 178 (1922) and 1455 (1923), in which he calls for a revision of the laws of electromagnetism have been reproduced in French in the "Revue Générale de l'Électricité" and criticised. The author here discusses very thoroughly the errors into which Hering has fallen, mainly from trusting to inadequate statements in elementary textbooks. Most if not all the points here dealt with have troubled many students, who will find the present paper extremely instructive. G. W. DE T.

632. *Derivation of Electromagnetic Fields from a Basic Wave-Function.* **H. Bateman** and **P. Ehrenfest.** (Nat. Acad. Sci., Proc. 10. pp. 369–374, Sept., 1924.)—An expression for a logarithmic wave-function is obtained, and expressions for the electromagnetic field obtained from this. The paper is wholly mathematical. F. S.

633. *Torque on a Cylindrical Magnet through which a Current is Passing.* **J. Zeleny** and **L. Page.** (Phys. Rev. 24. pp. 544–559, Nov., 1924.)—The torque acting on a vertical magnet, free to rotate about its axis, when an electric current is sent into the magnet by means of a horizontal arm attached at the central portion of its length and taken out along the axis, is usually ascribed either to the action of the field of the magnet on the current in the horizontal arm or to the action of the field of the current in the magnet on the poles of the magnet. But with a symmetrically magnetized magnet the latter torque reduces to zero whereas the action on the horizontal arm is opposite to the torque actually observed. The predominating torque which is overlooked is that resulting from the action of the magnetic flux through the magnet on the entering current sheet. Theoretical equation.—It is shown that if a current enters along the peripheral surface of a symmetrically magnetised cylindrical magnet, the total torque is $i\mathrm{N}/2\pi$ where i is the c.g.s. current flowing and N the flux cutting the current sheet. The same relation holds when the magnetisation is not symmetrical if the current enters the magnet in a symmetrical manner through a peripheral ring of the surface. If the current enters a magnet through the whole base over which there is a uniform magnetic induction, then the torque is $i\mathrm{N}/4\pi$. Experiments made with a symmetrically magnetised magnet with the current entering the magnet from a salt solution at peripheral rings at various places along the length of the magnet and leaving at the axis, verify the formula deduced. The same formula was found to agree also with experimental results obtained when a brass cylinder in the field of a solenoid replaced the magnet, showing that poles are without effect. The torque on a magnet when the current entered through a side arm was found to be the less the longer the side arm. AUTHOR.

634. *Coulomb's Law and the Hydrogen Spectrum.* **E. B. Wilson.** (Nat. Acad. Sci., Proc. 10. pp. 346–348, Aug., 1924.)—Coulomb's law has been assumed to hold for circular orbits of the hydrogen atom, but the author considers the question whether the law of Coulomb is really implied by the quantum theory; and working from the equations of motion for the electron, including the quantum condition, arrives at expressions which hold when the force varies as the inverse cube, and the quantum condition imposes no restriction on the size of the orbit, the force and potential energy depend on the quantum number; it is the force which is quantised and not the orbit. The differential equation is shown to have another solution corresponding to Coulomb's law. H. N. A.

635. *Electrical Charge on the Earth's Surface.* **C. Ramsauer.** (Ann. d. Physik, 75. 5. pp. 449–458, Oct., 1924.)—A direct method of measuring the earth's surface charge is described. It depends on comparing that charge with the neutral-atom state, by isolating a thin metal sheet, level with the earth's surface, and covered with a metal lid. It is found that the charge, in round numbers, for one square meter of the earth's surface is 1×10^{10} electrons. W. A. R.

DISCHARGE AND OSCILLATIONS.

636. *Ionisation of Hydrogen.* **T. R. Hogness** and **E. G. Lunn.** (Nat. Acad. Sci., Proc. 10. pp. 398–405, Sept., 1924.)—Gas, in this particular work, hydrogen, is ionised by a stream of electrons emitted from a hot filament and accelerated by a known field. The ions produced are drawn through a slit by an electric field and deflected on to the slit of an ionisation chamber. In working, the field accelerating the ions is varied until the electrometer deflection is a maximum, and then the energy of the ionising electrons lowered until the ions cease to be formed. The apparatus is fully described, and results obtained with hydrogen given. With hydrogen there first appear H_2^+ ions at a potential of 15·7 volts. At 16·6 volts the ions H^+ and H_3^+ appear simultaneously. No trace of negative ions could be detected. Hence the ionisation seems to be according to the schemes $H_2 = H + H^+ + E^-$, $H_2 = H_2^+ + E^-$, and the secondary action $H^+ + H_2 = H_3^+$. A. Wh.

637. *Mobilities of the Positive Ions in Helium.* **H. B. Wahlin.** (Nat. Acad. Sci., Proc. 10. pp. 475–478, Dec., 1924.)—The work here described was undertaken to see if the "ageing" effect on the mobility could be obtained in a monatomic gas, previous experiments having shown that if the mobility of the positive ion in air was determined immediately after the formation of the ion, the value found was 1·89 cm./sec./volt/cm., while if the ion was aged for about half a second the value found was that usually ascribed to the positive ion, 1·35 cm./sec./volt/cm. The method employed was the same as in previous work [Abstract 194 (1923)]. The mobility curves obtained showed breaks which may be due to the presence in helium, under the influence of α-particle ionisation, of two types of aged and two types of unaged ions having different mobilities. The ions corresponding to the part of the mobility curves below the break were present in small numbers so that it was impossible to determine the intercept with any degree of accuracy. The mobilities computed from the intercept for that reason varied over a 25 % range. Those computed from the breaks did not show so great a variation. The average of seventeen determinations gave the values:—

Aged Ions.		Unaged Ions.	
Break.	Intercept.	Break.	Intercept.
513	7·17	8·70	13·30

Franck observed one value for helium, 5·09 cm./sec./volt/cm. This would correspond to the value 5·13 given above. [See Abstract 2832 (1924).]

A. W.

638. *Electrical Formation of Nitric Oxide.* **G. M. Schwab** and **S. Loeb.** (Zeits. phys. Chem. 114. pp. 23–43, Dec. 13, 1924.)—The formation of nitric oxide from oxygen and nitrogen in a direct current arc was studied. The apparatus used consisted of a cooled arc in a specially designed container in which the pressure could be varied at will, a pressure of 6 mm. being employed in the experiments. The velocity of formation of nitric oxide is approximately constant at a nitrogen concentration of 20–80 %. The velocity falls to zero outside these concentrations. The velocity of decomposition of nitric oxide is found to depend on the method by which the discharge is effected. It was shown that the optical absorption law can be utilised, independently of the energy distribution in the arc for the "activation" of the components.

It was concluded from the experimental results obtained that a great portion of the energy absorbed by the oxygen was inefficiently utilised, but a portion of this energy served to "activate" the nitrogen by the bombardment of the nitrogen molecules by the oxygen ions. The energy absorbed by the nitrogen for which the absorption law holds, is, under the experimental conditions, only a small portion of the total amount. The greater portion is lost by rebound from the electrodes.

F. J. B.

639. *Present Position of the Theory of the Glow Current.* **R. Holm.** (Phys. Zeits. 25. pp. 497–535, Oct. 15, 1924.)—This is a synopsis of the investigations which have been carried out on the subject, and a comprehensive list of the principal papers is given at the end. The following are among the points dealt with: mobility and formation of ions; ionisation and excitation; the setting free of electrons from metals by means of canal ray collisions; the Townsend discharge form; dependence of the normal kathode on kathodic material and the gas; the current density at the kathode; the theory of the kathodic discharge; the kathode fall of arc lights; the anode fall; the positive layers. The electric spark, electrodeless discharge and corona are also considered.

A. E. G.

640. *The Glow Discharge.* **A. Günther-Schulze.** (Zeits. f. Physik, 30. 3. pp. 175–186, 1924. From the Reichsanstalt.)—If with the normal glow discharge the anode and kathode are brought near to one another, the anodic glow skin vanishes at a sharply defined distance D. At the same time the tension is altered round about the amount of the ionising tension of the used gases. For a given gas $p \cdot D = \text{const.}$ where $p =$ the gas pressure. Further, if V_a = the tension between the electrodes $p \, . \, D/V_a^2$ = const. in N_2, O_2, and H_2O, on the other hand $p \, . \, D/V_a$ = const. approximately, in H_2. Ar. shows a completely irregular behaviour. The thickness of the anodic glow skin is almost completely independent of the gas pressure at greater gas pressures. If two parallel kathodes are connected to the same anode, and if so large a tension exists between both the kathodes and the anode that both kathodes are completely covered by the glow discharge, then so soon as the two kathodes are brought so near to one another that the primary electrodes enter the opposite lying fall space, the current strength begins to rise. The distances of the kathodes with which an increase of 10 % of the current takes place are smaller than the distance D. A. E. G.

641. *Metastable States in Low-Voltage Mercury Arcs.* **M. Marshall.** (Astrophys. J. 60. pp. 243–255, Nov., 1924.)—Current-potential curves for alternating and intermittent arcs in pure mercury between a hot filament kathode and nickel disc anode were obtained by use of a Braun tube oscillograph for pressures of from 0·001 to 10 mm. with alternating voltages, the striking potential for 10 cycles and less was about 12 volts, but for frequencies of 10 cycles and above the current started at 3·0 volts and soon reached a saturation value until 8·0 volts, when a further increase was produced. To form the intermittent arc the voltage was periodically dropped from 15 to some lower predetermined value. If this lower value was less than 3·0 volts, the arc was suddenly extinguished, at 3·0 volts the arc was maintained, and at 3·8 volts there was a sudden slight increase in arc current that was maintained for a very short time; at 8·4 volts the current was maintained at a higher current value. If 2 volts are added to the above observations, the results agree with the voltages corresponding to the $2p_1$ and $2p_3$ energy-levels and to the ionisation potential of the mercury atom. Evidence as to the lines of the two metastable forms of the mercury atom.—From spectroscopic data it has been suggested that the $2p_1$ and $2p_3$ energy-level of the mercury atom are metastable, and remain in this condition for an appreciable time. The above results confirm this, and give as a value for this time: for the $2p_1$ state 1/22 of a second, for $2p_3$ state 1/170 of a second. Dependence of life of metastable mercury on pressure.—The critical frequency of metastable mercury ranged from 45 to 12 cycles in the pressure range from 0·08 to 1 mm. Above 1 mm. the life was independent of pressure. This phenomenon is explained as due to collisions with impurities and diffusion from the arc space. AUTHOR.

642. *On the Nature of the Ions in Air and in Carbon Dioxide.* **H. A. Erikson.** (Phys. Rev. 24. pp. 502–509, Nov., 1924.)—Mobilities of ions of air and CO_2 in initial and final stages.—It has previously been shown that in air the positive ions have an initial mobility equal to that of negative ions, 1·87 cm./sec./volt/cm., which decreases in about 1/50 sec. on the average to 1·36 cm./sec./volt/cm. Using improved apparatus with an air speed of 20 m./sec. and fields of over 1000 volts/cm., curves were obtained showing clearly the presence of both initial and final ions. These are the same whether α- or β-rays are used to produce the ions. Negative ions show only one mobility. CO_2 ions gave curves which, within experimental error, agree with those for air, indicating one negative and two positive ions, but the time of transition to the final positive stage is somewhat shorter for CO_2. These results are best explained by assuming that in these cases ionisation involves merely the detachment of an electron from a molecule, leaving a positive mono-molecular ion which soon attaches itself to a neutral molecule forming the final somewhat unstable bimolecular positive ion, while the electron almost immediately joins a neutral molecule forming a stable negative mono-molecular ion. Dissociation seems to play only a small part. It is concluded that single molecules singly charged, positively or negatively, all have about the same mobility which is independent of mass and molecular volume, and that a singly charged cluster of two or more molecules, not forming a single molecule, has a smaller mobility. AUTHOR.

643. *The Ionisation of Potassium Vapour by Light.* **R. Samuel.** (Zeits. f. Physik, 29. 3–4. pp. 209–213, Nov., 1924.)—Theory indicates that gases should be ionised by light for which $h\nu$ is equal to, or greater than, the ionisation energy, and that frequencies near the absorption series limit of the gas should produce a larger effect than higher frequencies. This has recently been verified in the case of potassium vapour by R. C. Williamson; and the author, who was working along the same lines at the time of this publication, now describes the apparatus employed by him, and his results. The potassium was purified by repeated distillation in a series of bulbs of hard glass attached to the apparatus; and by heating the last of these bulbs in an electric furnace a molecular stream of potassium vapour was produced, which passed upward into the observation space; here a beam of light passed through the stream at right angles to its direction, without illuminating any of the metal portions of the apparatus, so that all extraneous photoelectric effects were avoided. The stream passed upwards into a double Faraday cage, the inner cage being connected to an electrometer; a metal plate with a hole in it, through which the molecular stream passed, was placed at the bottom of the observation space, and a potential difference of 1 to 1·5 volts was applied between this plate and the cage, so that the positive ions went to the cage and the electrons to the lower plate. As the effect obtained was small, it was not possible to use a monochromator, and filters were employed instead to isolate a definite spectral region; these were combined with a magnesium arc lamp, which gives two very strong lines in the region required, the wave-lengths of which, 2852 Å. and 2804 Å., lie just below the series limit, 2857 Å., of potassium. It was shown that, when light of wave-lengths shorter than 2893 Å. was cut off by a suitable filter, the rate of charge was the same as without illumination, while when wave-lengths as small as 2804 Å. were allowed to pass the rate of charge was considerably increased; the charge in the first two cases was due to thermal ionisation. No increase in the effect could be observed when wave-lengths shorter than 2804 Å. were employed. H. N. A.

644. *Shock between Atoms and Electrically-charged Particles.* **E. Fermi.** (Zeits. f. Physik, 29. 6. pp. 315–327, 1924.)—The electric field of a charged particle passing an atom is harmonically distributed; comparison with the electric field of passing light with a given distribution of frequencies. The assumption is made that the probability of the atom being stimulated or ionised by the passing particle is the same as that of its being equally affected by an equivalent radiation. Following up this assumption, the question of stimulation by electron-masses is investigated, as also that of ionisation and the range of α-rays. [See also Abstracts 1872 and 2553 (1924).] A. D.

645. *Electron Emission from Adsorbed Films on Tungsten.* **K. H. Kingdon.** (Phys. Rev. 24. pp. 510–522, Nov., 1924.)—Electron emission from tungsten filaments covered more or less completely with adsorbed films.—(1) Complete film of oxygen.—The emission corresponds to the equation $i = AT^2e^{-b/T}$ where $A = 5 \times 10^{11}$ amps./cm.^{2} deg.^{2}; $b = 107{,}000°$. It was necessary to supply oxygen continuously to keep the film complete. (2) Thorium film covering a fraction θ of a thoriated tungsten filament. —The data obtained with three tubes agree with the empirical expression

$$i_\theta = [a_1{}^\theta + a_2{}^{(1-\theta)} - 1]A_0T^2e^{-[b_1\theta+b_2(1-\theta)]/T} \quad \ldots\ldots\ldots\ldots (1)$$

where a_1 and a_2 are the numerical values of A for a complete film of Th on W and for pure W respectively, expressed in terms of the dimensional unit $A_0 = 1$ amp./cm.^{2}deg.^{2}, and b_1 and b_2 are the respective values of b. The present experiments give $a_1 = 7$, $b_1 = 31{,}200°$; from the results of other workers, $a_2 = 60$, $b_2 = 52{,}200°$. (3) Cæsium films on tungsten covered with oxygen.—Complete films of Cs were not obtained, but the results indicate $A_{Cs} < 0{\cdot}003$ amp./cm.^{2} deg.^{2} and b_{Cs} slightly less than 8300°. Such low values, together with the values for an oxygen film, substituted in Equation 1, give a curve which shows a maximum emission for $\theta = 0{\cdot}993$ instead of the expected $1{\cdot}00$. Various experiments on the effect of varying the pressure of Cs vapour and on the effect of evaporating Cs from the surface confirm this conclusion, and also the variation of A and b with θ. (4) Cæsium films on tungsten.—The maximum emission is computed to be for $\theta = 0{\cdot}987$. (5) Effect of adding nitrogen to fully activated thoriated tungsten is to increase the emission about five-fold at 1400° K. A pressure of $0{\cdot}1\ \mu$ is sufficient. The effect seems to be due to a change in the A value. AUTHOR.

646. *The Variation of Thermionic Emission with Temperature and the Concentration of Free Electrons within Conductors.* **A. T. Waterman.** (Phys. Rev. 24. pp. 366–376, Oct., 1924.)—Equilibrium electron theory of thermionic emission.—The equation for the thermionic saturation current per unit area in the form $I = AT^{\alpha}e^{-b/T}$ is derived according to Richardson's thermodynamical method, assuming (1) the boundary condition that, when ψ, the free-electron evaporation constant, is zero, the free-electron concentration inside and outside the hot body is the same, and (2) the interior free-electron concentration given by the author's equilibrium theory of conduction [Abstract 622 (1924)]. α depends only upon the valence in the electron-forming reaction, and always lies between 1/2 and 5/4. β depends upon the valence and the two evaporation constants ϕ_0 and ψ_0, referring respectively to a bound and a free electron. A is found to depend upon the valence, the electronic chemical constant, and the concentration of electron-forming particles in the hot body, varying from $4{\cdot}16(10)^{14}$ for BaO to $8{\cdot}13(10)^{14}$ for Ni. Values of β calculated from the computed A and experimental data show excellent agreement with β observed for Pt, W, Mo, Ni, Ca, CaO, SrO, and BaO, the verification being more general than by use of Dushman's formula. The experimental data, however, are not sufficiently accurate to decide between the two formulas. The failure of certain hot bodies to agree with either formula is discussed and possible explanations offered. Assuming the theory correct, the free-electron concentrations in several metals, MoS_2 and CaO, are calculated from experimental data. For metals at 0° C. this concentration is of the order of magnitude 10^{17} per c.c., and decreases with rising temperature. A noteworthy consequence of this low concentration is that the contribution of the free electrons to the specific heat of the conductor remains negligible down to very low temperatures. AUTHOR.

647. *The Thermic Emission of Electrically-charged Particles.* **H. J. Spanner.** (Ann. d. Physik, 75. 6. pp. 609–633, Nov., 1924.)—After a brief introduction the following questions are dealt with: (*a*) Is there any connection between the emission of electrons and the conductivity of a particular substance? (*b*) Is there a similar connection of the thermic electron emission with the electric character of the emitting substance (electro-positive or negative) as there is with the photo-effect, or is it possible to establish a direct connection with the order of the element in the periodic system? (*c*) Can the electron emission of a simple compound be determined from that of its components? As a result of the present investigation it is considered that the electron emission of a compound may be stated as follows: electron emission of a compound = emission of the single parts + disturbing element (which, in spite of the chemical combining force, can probably be neglected). The answer to question (*c*) is contained in this equation, although the result must be regarded as qualitative only on account of the difficulty of making the measurements. A. E. G.

648. *Amplification of Short Waves.* **H. Riegger** and **F. Trendelenburg.** (Zeits. techn. Physik, 5. 11. pp. 495–500, 1924.)—This paper deals with the amplification of wave-lengths ranging from 1000 to 70 m. Measurements were made of the amplification given by one, two, three or four stages of an amplifier with choke-capacity coupling. The transmitter and the amplifier under test were both specially screened by earthed metal boxes, which also enclosed all the necessary batteries. The only portion of the transmitter outside the screen was the coupling coil, which was wound in toroidal form so as to have as small an external field as possible. The dynamic characteristic of the arrangement was first obtained, and then the amplification factor was determined for different wave-lengths. The results are presented graphically. A. W.

649. *Characteristics (Reissdiagramme) of Transmitting Valves.* **H. Rukop.** (Zeits. techn. Physik, 5. 6. pp. 260–266; 5. 7. pp. 299–312; 5. 9. pp. 387–397; 5. 10. pp. 441–450, and 5. 12. pp. 596–624, 1924.)—The theory of valve excitation with retroaction introduces non-linear variables, and as a consequence many interference effects occur in practice. The subject has been extensively treated by Möller, Rukop, Mauz and Zenneck, Blondel, Appelton, van der Pol and others with reference to hysteresis (Ziehen) effects. Möller utilises a method based partly upon direct measurements, partly on mathematical calculations and partly on graphical methods. Mathematical methods are limited by the difficulties introduced when it is attempted to express mathematically the variations of current and voltage. The present writer, after much experimental experience, puts forward a new method based upon "Reissdiagrammes," which are diagrams representing curves and surfaces having as abscissæ the direct-current grid voltage and as ordinates the high-frequency current strength. These are quite independent of wave-lengths, unless extreme regions are considered. This exposition includes the subject of hysteresis (Ziehen) and other discontinuous effects. The methods and diagrams are extremely involved and incapable of abstraction. The whole subject of valve phenomena is very systematically and deeply treated, and the present paper appears to be of fundamental importance. B. J. L.

650. *Gridless Receiving and Amplifying Valves with Control Plates.* **H. Cohn.** (Zeits. techn. Physik, 5. 11. pp. 500–505, 1924.)—Describes research on the properties of valves in which the filament is situated between the flat anode and a parallel control plate which takes the place of the usual grid. Various arrangements were tried to reduce the control plate current, and in the arrangement finally adopted the control plate has a U-shaped depression down the centre, and the filament is stretched in the middle of this depression in the plane of the rest of the plate. The dependence of the valve characteristics on size of control plate, distance between control plate and anode, constitution of filament, etc., was investigated, and the results are shown graphically for various types of control plate. In the valve finally evolved, which has a thoriated tungsten filament working at 0·08 amp. on 1·2 volts, the anode characteristic has a slope of 0·2 m. amp./volt with 50 volts on the anode, values about the same as are given by ordinary valves with grids instead of control plates. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

651. *A Mathematical Treatment of the Electric Conductivity and Capacity of Disperse Systems.* **H. Fricke.** (Phys. Rev. 24. pp. 575–587, Nov., 1924.)—Conductivity measurements may give values for (1) the specific conductivity, (2) the concentration, or (3) eccentricity of form of the suspended particles of suspensions, such as biological tissues, blood and cream. Mathematical theory.—The following relation is derived: $(k/k_1 - 1)/(k/k_1 + x) = p(k_2/k_1 - 1)/(k_2/k_1 + x)$, where k, k_1 and k_2 are the specific conductivities of the suspension, the suspending medium and the suspended spheroids, p is the volume concentration of the suspended spheroids, and x is a function of the ratio k_2/k_1 and the ratio a/b of the axis of symmetry of the spheroids to the other axis. For the case of spheres, $x = 2$, and the formula reduces to that of Lorentz-Lorentz and Clausius-Mossotti. Curves are given showing the variation of x with k_2/k_1 for various values of a/b. Comparison with experimental data of Stewart for the conductivity of the blood of a dog ($k_2 = 0$, $a/b = 1/4{\cdot}25$, $x = 1{\cdot}05$) shows excellent agreement for concentration from 10 to 90 %. Also the observations of Oker-Blom for two suspensions of sand in salted gelatine give in each case constant values of x for various concentrations. AUTHOR.

652. *Conductivity of Vaporised Salts in Flames.* **S. Kalandyk.** (J. de Physique et le Radium, 5. pp. 345–352, Nov., 1924.)—To avoid the difficulty associated with the introduction of aqueous solutions into the chloro-hydrogen flame the salt is carefully mixed with sea sand and thus introduced into the flame dry, but in definite concentration. As the concentration of the salt increases the conductivity passes through a maximum. The method of experiment does not give certain information for low concentrations, but the results obtained with potassium chloride and sodium chloride seem to indicate that for low concentrations of these salts the current intensities grow proportionally to the concentration. In both flames used the conductivity possesses a unipolar character. In the oxy-hydrogen flame it corresponds to a greater mobility of the negative ions; in the chloro-hydrogen flame to a greater mobility of the positive ions. There is, however, a great difference between the character of the two flames, the conductivity of the salt in the oxy-hydrogen flame depending essentially on the temperature of the kathode. Incandescent platinum in an atmosphere of chlorine is found to give out a greater number of negative than of positive ions. G. A. S.

653. *Change of Conductance of Selenium Due to Electronic Bombardment.* **R. de L. Kronig.** (Phys. Rev. 24. pp. 377–382, Oct., 1924.)—Effect of electronic bombardment on the conductance of selenium.—A low-resistance selenium cell about 1 inch square made by pressing Se between twenty double turns of fine Pt wire, was mounted in a vacuum tube with a grid and an oxide-coated, equipotential, electrically heated kathode and subjected to bombardment by electron currents up to 400 μ amps. at potentials up to 95 volts. The increase of conductance ΔC with current I and with voltage V, is found to agree well with the theoretical formula $\Delta C/C = \sqrt{1 + kIV} - 1$, derived on the basis of the free electron theory of conduction, assuming that the impinging electrons increase the number of free electrons throughout the whole volume of the Se by ionisations proportional both to the number of electrons and to the energy of each, *i.e.* to IV. The constant k is the ratio of the ions created per watt to the number of ions produced spontaneously per sec. and comes out 00·5. AUTHOR.

654. *Variation of Metallic Resistance with Temperature.* **K. Lichtenecker.** (Phys. Zeits, 25. pp. 550–551, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Making a simple assumption as to the mechanism of conductivity in metals, a theoretical formula is deduced for the variation of resistance with temperature which is shown to fit experimental results very closely. G. A. S.

655. *Hall Effect in a Conductor Due to Its Own Magnetic Field.* **W. van B. Roberts.** (Phys. Rev. 24. pp. 532–543, Nov., 1924.)—If there is at each point in a conductor an electric intensity proportional to the vector product of the magnetic field and current density, there should be a difference of potential between points at different distances from the axis of a cylindrical conductor carrying a current. Rather than attempt to measure this, a qualitative confirmation of the existence of the effect was sought by use of a cylindrical specimen of bismuth having a long section of small diameter (3 to 4·8 mm.) between two larger end sections (12·5 mm.). When 60-cycle alternating current was sent through the specimen, the mean potential differences between the surface of the small section at the point M and two points A and B on the surface of the larger sections at each end, was measured by means of a tuned electro-dynamometer connected from M to the balance point on a semicircular conductor connecting A and B, at which the 60-cycle potential differences were balanced out. This Hall effect has a double frequency because it does not reverse with the current. The resulting deflections were from 0·1 to 0·3 times the theoretical upper limit, therefore in good qualitative agreement. That they were not due to thermoelectric effects was proved by the absence of the effect when an alloy with zero Hall coefficient was substituted, as well as by other tests. It is concluded that the Hall effect is always present in wires carrying currents and should cause a slight increase of resistance at high current densities. **Author.**

656. *Electrical Resistances of Metallic Aggregates.* **W. Esmarch.** (Phys. Zeits. 25. pp. 484–485, Oct. 1, 1924.)—A reply to a criticism of the author's work. [See Abstract 2333 (1924).] G. A. S.

657. *Temperature Coefficients of Electrolytic Resistances.* **J. Malsch** and **M. Wien.** (Phys. Zeits. 25. pp. 559–562, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—P. Walden, extending researches of Kohlrausch and Grotrian, propounded the following laws: (1) The product of the viscosity and the conductivity at infinite dilution is constant for the same solute in different solvents; (2) the temperature coefficient of the viscosity and that of the electrolytic conductivity at infinite dilution are equal. In apparent contradiction to these laws are the facts that in the case of acids and acid salts in aqueous solution the temperature coefficient of conductivity is actually smaller than the temperature coefficient of viscosity of water and that with non-aqueous solutions there are very small and even negative temperature coefficients of conductivity. The present experiments show that when the electrolyte is traversed by current impulses of short duration the temperature coefficient found has not the normal value that accompanies prolonged heating. The phenomenon is systematically investigated. The duration of the impulses is varied two hundred-fold. Different electrolytes are used, some of them with abnormal temperature coefficients as usually measured. Finally the concentration is also varied. The following results are obtained: (*a*) With sudden warming the temperature coefficient is essentially determined by that of the viscosity. It is the same for all ions in aqueous solution, *viz.* 2·2 %. The ions are still unchanged and their movement follows the friction laws undisturbed. (*b*) If the heating has lasted a somewhat longer time, say 10^{-6} or 10^{-5} seconds, changes of the temperature coefficient appear which according to Kohlrausch's assumption are attributable to changes in the constitution of the electrolyte. The reactions ensue the quicker the greater the concentration. This cannot well be explained otherwise than by supposing that the reaction depends upon mutual influence of the ions which follows the more quickly the smaller their distance apart and the more probable their collision is. G. A. S.

658. *Some Effects of Gas upon the Resistance and Resistance-Temperature Coefficient of Sputtered Platinum Films.* **F. W. Reynolds.** (Phys. Rev. 24. pp. 523–531, Nov., 1924.)—Effects of oxygen and heat treatment on the resistance and temperature coefficient of resistance of sputtered Pt films.—Films 8 mm. square were each sputtered in air at 0·02 mm. on a blank kept at any desired temperature T up to 450° C. by means of a heating coil. Resistance temperature curves made in a vacuum of 1 μ of Hg at temperatures below T are reproducible straight lines. For "thin films" (resistance $<$ 500 ohms) the coefficient is positive and increases with ageing at high temperatures, approaching the value of bulk metal. For "very thin films" (resistance $>$ 500 ohms) the coefficient is negative,

but becomes positive by exposure to O_2 while hot. Heat treatment alone will not cause a reversal in the coefficient. The effect of oxygen at room temperature on thin films sputtered cold is to decrease the resistance slightly, while if the films are sputtered hot and then cooled the effect is a slight increase. The resistance of very thin films when exposed to O_2 at a temperature above a minimum (80 to 200°) depending on the film, increases very rapidly and would soon become infinite, but if cooled decreases again in time and soon reaches a value below the initial resistance. Other gases tried, H_2, He and CO_2, had practically no effect. It is suggested that the low values of the temperature coefficient are due to H_2 absorbed during sputtering, and that the effects of the O_2 are partly due to chemical action with the H_2 and partly to absorption of the O_2.
AUTHOR.

659. *Thermoelectric Condition of Pure Iron at its Transition Points.* **A. Goetz.** (Phys. Zeits. 25. pp. 562–571, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Apparatus is described which aims at determining the thermoelectric properties of pure iron at the different stages of its modification up to near the melting point. The measurements show that for the change from the space-centred cubical lattice to the surface-centred cubical (β-iron to γ-iron) a great decrease of dE/dT takes place, while for a transformation in the reverse direction (γ-iron to δ-iron) there is an increase. The space-centred lattice is thus seen to be thermoelectrically positive to the surface-centred one. A connection is shown to exist between the thermoelectric properties and the magnetic and thermo-ionic properties in similar circumstances and a probable parallel with the thermoelectric properties of iron under dilatation and compression is indicated.
G. A. S.

660. *The Normal and Selective Photoelectric Effects in the Alkali Metals and Their Alloys.* **H. E. Ives** and **A. L. Johnsrud.** (Astrophys. J. 60. pp. 231–242, Nov., 1924.)—The photoelectric currents from specular surfaces of molten sodium, potassium, rubidium, and cæsium, and their alloys, are studied at various angles of incidence for the two principal planes of polarisation. The selective photoelectric effect is clearly exhibited only in the case of the liquid alloy of sodium and potassium. Wave-length distribution curves show maxima of emission, which are usually, but not always, most pronounced for light polarised with the electric vector parallel to the plane of incidence. The wave-length maxima previously assigned to the several elements are not confirmed; the maxima vary in position for the same element with the condition and mode of preparation of the surface.
AUTHORS.

661. *Photoelectric Properties of Thin Films of Alkali Metals.* **H. E. Ives.** (Astrophys. J. 60. pp. 209–230, Nov., 1924.)—The thin films of alkali metals which deposit spontaneously on clean metal surfaces in highly exhausted inclosures are studied. The alkali metals, sodium, potassium, rubidium, and cæsium, in the thin film form all exhibit, to a striking degree, the selective photoelectric effect first discovered in sodium potassium alloy. Experiments on varying the thickness of the deposited film show that the selective effect only occurs at a certain stage of the film's development; for very thin films the selective effect is absent, and it disappears again for thick layers of the pure alkali metal. The wave-length maxima of emission previously ascribed to the selective effect in the pure alkali metals on the basis of observations with rough or colloidal surfaces are absent in these thin films. AUTHOR.

662. *The Mechanism of the Photoelectric Primary Current in Crystals.* **B. Gudden and R. Pohl.** (Zeits. f. Physik, 30. 1. pp. 14–23, 1924.)—The authors have published a series of papers on the above subject [Abstract 1265 (1924)], and at first used the expression "primary current" for the wandering of the electrons split off by the action of light. The secondary current is due to a diminution of the specific resistance resulting from the primary action. In addition to the primary and secondary currents they have observed a third component, which they have called the positive portion of the primary current. They have now investigated the action of light of different long wave-lengths in producing this positive portion. Narrow strips of a continuous spectrum were separated out by a monochromator, and passed through a diamond, which had been acted on by short wave-length light and thus "ionised"; that is to say, electrons were split off from some of the atoms of the lattice, which passed to the anode, leaving the positive ions in position. The effect of the long wave-length light is to cause the positive charge to travel towards the kathode, the authors' idea being that an ion takes up an electron from the neighbouring atom, which thus becomes a positive ion, so that the charge $+e$ has travelled by a minute step towards the kathode. This is repeated again and again for all the ions until the crystal is discharged. Light of wave-lengths from 630–660 mμ proved to be most effective in producing this effect, the optical absorption extending further towards the red when the lattice is disturbed by the positive charges, which remain after the negative portion of the photoelectric primary current has discharged itself. Apparently, as far as the mechanism of conduction is concerned, the photoelectric phenomenon may be dealt with in all crystals in the same way. H. N. A.

663. *Relation of Thickness of Layer to the Photoelectric Effect in Dyes.* **A. Predwoditelew and N. Netchaewa.** (Zeits. f. Physik, 29. 6. pp. 332–342, 1924.)—The connection between the photoelectric saturation current and the layer thickness is investigated for the following dyes: fuchsin, crystal-violet, trimethylrosanilin, methylviolet B extra. The current as function of the layer thickness shows a certain periodicity. A possible explanation of the results obtained is given, starting from the assumption of a reciprocal action of the molecule. A. E. G.

664. *Photoelectric Emission from Selenium.* **W. del Regno.** (Accad. Lincei, Atti, 33. ii. pp. 163–167, Sept., 1924.)—Referring to the researches of M. J. Kelly on photoelectric emission from insulators [Abstract 124 (1921)] the author describes experiments made to ascertain whether the liberation of electrons from selenium changes with the transition from darkness to light. The cell consists of a film of selenium, 30 mm. sq., in a box illuminated by a quartz mercury lamp or a glow lamp of 100 candles. Observations first made with a Wilson electroscope and then with a Dolezalek electrometer showed only very slight differences within the experimental errors, due possibly to thermal effects. In order to separate thermal and photoelectric effects series of experiments were then made on the time intervals giving equal deflections after attaining constant temperature by comparing the last observation of a series in the dark with the first of a series in the light. The conclusion arrived at is that there is no difference in the emissions of electrons from selenium in the dark and in the light, and that free electrons do not enter into the photoelectric behaviour of selenium. That is also said to confirm the author's previous conclusion that the change, by exposure to light, in the conductivity of selenium is purely electronic in character, and not due to any chemical allotropic modification. H. B.

665. *The Relation between the Mechanical and Piezo-Electrical Properties of a Rochelle Salt Crystal.* **F. G. Isely.** (Phys. Rev. 24. pp. 569–574, Nov., 1924.)—Stress-strain curves for a Rochelle salt crystal for 16 to 36° C.—A crystal cut so as to give maximum piezo-electric response under compression, was mounted so that a known force was applied to the centre of a brass block resting on the top, and the corresponding strain was measured to within 10^{-6} mm. by means of an optical extensometer described by S. R. Williams. Variation with piezo-electric charge.—When the load is applied, the initial strain is less than the final strain by an amount proportional to the initial piezo-electric charge, the difference varying with the temperature and reaching a maximum for 22·25°, the temperature of maximum piezo-electric response. For a stress of 2225 gm./cm.^{2}, the strain with the charge is less than the "no charge" strain by an amount $0 \cdot 7 \times 10^3$ per coulomb per cm.^{2}; for this stress the initial and final strains were 9·5 and $13 \cdot 4 \times 10^{-5}$, the corresponding moduli being 2·32 and 1·62, both times 10^{10} dynes. The final strain is independent of temperature; it is not proportional to stress, being $7 \cdot 5 \times 10^{-5}$ for 1 kg./cm.^{2} and $12 \cdot 5 \times 10^{-5}$ for 2 kg./cm.^{2}. AUTHOR.

666. *Dielectric Anomalies in Rochelle Salt Crystals.* **J. Valasek.** (Phys. Rev. 24. pp. 560–568, Nov., 1924.)—The throw of a ballistic galvanometer connected to a condenser with Rochelle salt crystal as dielectric depends on the time of charging and the time of discharging. It increases to a maximum as the charging time is increased to 2 sec. (for crystal plates 0·15 cm. thick) and then decreases slowly, reaching for a time of 24 hours a value about half the original. The decrease of the throw for 0·03 sec. charging, due to fatiguing for 24 hours at 100 volts, was found to be nearly independent of the temperature from − 15° C. to + 20° C. The first increase is probably due to residual charges which are easily displaced to a more or less definite limit and which account for the high dielectric constant in this temperature range. The subsequent decrease is due to a fatigue effect which may be likened to an electrolytic polarisation of the internal displacement current. These effects are associated with the water of crystallisation, since desiccation decreases them, while previous soaking in alcohol accelerates them. To explain the limited temperature range of the effects it is supposed that at − 20° C. there is a loosening of the water ions enough to permit a slight motion of about 10^{-9} cm. with reference to the Rochelle salt molecules, while at temperatures above + 25° C. further loosening allows electrolytic conduction to increase greatly. Thermal changes in Rochelle salt.—There is apparently an evolution of heat starting at 24° C. and persisting to 54° C. where a very strong absorption of heat takes place. AUTHOR.

667. *Electrical Constants of Dielectrics for Radio-frequency Currents.* **R. V. Guthrie, Jr.** (Inst. Radio Eng., Proc. 12. pp. 841–847, Dec., 1924.)—The source of power losses in a condenser may be considered as a resistance in series or in parallel with the condenser. If the resistance is considered as in series, the capacity must be considered as the effective capacity, and the power factor is given by a simple formula. If the resistance is considered as in parallel, the capacity must be considered as a pure capacity, and knowing the pure capacity with the given dielectric, and with air in turn between the plates of the condenser, the quotient of the former by the latter is the dielectric constant. The dielectric constants of several solid dielectrics were found to be approximately constant over the band of frequencies investigated, and the power factors changed according to no apparent law. A table of electrical constants for a number of materials and for a frequency of 1,000,000 cycles per second is given. AUTHOR.

668. *Primary Radio-frequency Standardisation by Use of the Kathode-Ray Oscillograph.* **Grace Hazen and Frieda Kenyon.** (Bureau of Standards, Sci. Papers No. 489, pp. 445–461, 1924.)—A method of high accuracy has been developed for the primary standardisation of radio-frequency. Comparison is made between a tuning-fork of accurately known frequency with an electron-tube drive and a generating set of radio-frequency current by the use of two radio-frequency generating sets and Lissajous figures produced in a kathode-ray oscillograph. The apparatus used in this work consisted of a Bureau of Standards type R70B wave-meter which has a variable air condenser, 4 fixed mica condensers and 5 interchangeable inductors, a tuning-fork of 1024·2 cycles per second driven by a 5-watt electron-tube generating set, 2 radio-frequency generating sets each using a 250-watt electron tube, a kathode-ray oscillograph having a tube of the cold kathode type requiring from 18,000 to 20,000 volts to operate. The Lissajous figures were formed on the fluorescent screen by the alternating electric fields from two generating sets applied at right angles to each other and to the electron stream by means of condenser plates mounted on the tube. The procedure adopted was to adjust the second of the radio-frequency generating sets to a known multiple of the tuning-fork frequency by the use of the Lissajous pattern ratio produced in the kathode-ray oscillograph. The wave-meter was then brought into resonance with the radio-frequency generating set and read for the known frequency. A range from 1½ to 22 times the tuning-fork frequency was covered in this manner. The third radio-frequency generating set was then adjusted to a known multiple of the second generating set, still using the kathode-ray oscillograph. Radio-frequencies up to 22 times the second generating-set frequency were determined. The wave-meter circuit thus standardised was used as a basis for higher-frequency work. The second or lower-frequency generating set was set at a definite frequency from this standardised circuit, and the higher-frequency generating set adjusted to a multiple of it by means of the Lissajous figures. The range of the wave-meter standardised in this manner is from 3·5 to 5000 kilo-cycles per second. AUTHORS.

669. *Kathode-Ray Oscillograph with Electrostatic Focusing.* **L. T. Jones and H. G. Tasker.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9, pp. 471–478, Oct., 1924.)—This paper deals with the form of Braun tube in which a filament is used as the source of electrons. The authors state that the whole problem of a satisfactory tube lies in the definition of the spot on the screen and in the sensibility of the beam to deflection by electric and magnetic fields. The special feature of the tube produced by the authors is the method of focusing the spot on the screen. Reference is made to the oscillograph now marketed by the Western Electric Co., in which the focus is adjusted by varying the filament temperature, a feature of this oscillograph being that mercury-vapour is left in the tube after exhaustion. In the tube developed by the authors there are electrostatic focusing characteristics present quite apart from any effect due to residual mercury vapour. The kathode C consists of a disc 1·5 cm. diameter having a 2-mm. hole through its centre. The anode A is also pierced by a 2-mm. hole, and is placed about 2 cms. in front of the kathode disc. The screen S is of finely pulverised calcium tungstate deposited from ether. The oxide-coated filament F is placed about 0·5 mm. behind the kathode disc C. A small voltage, termed the exciting voltage, and conveniently taken from the generator G, is applied between filament and kathode. The remainder of the voltage of the generator is applied between kathode and anode. The screen distance is 25 cms. The value of the exciting voltage depends on the filament kathode distance. In the tube described it is less than 50 volts. The exciting voltage carries the electrons through the kathode disc and apparently through a focus a few millimetres in front of the kathode. The position of this focus is dependent on the filament temperature, exciting voltage, and probably driving voltage. The driving voltage produces a conjugate focus at the screen. Driving voltages above 300 are suitable. A spot diameter of about 1 to 1·5 mm. is obtained. With low frequency the behaviour of the tube is found to differ according as the deflecting plates are inside or outside the tube. When the deflecting plates are outside, the deflection is apparently a function of the number of electrons in the beam; with the deflecting plates inside, the deflection is a function of the electron velocity alone. The authors conclude by stating that the thermionic Braun tube is not reliable as an oscillograph for external fields of low frequency. Whether this peculiarity persists when the deflecting frequency is large remains to be determined and will be made the subject of a future paper. F. S. B.

670. *Self-contained Standard Harmonic Wave-Meter.* **D. W. Dye.** (Roy. Soc., Phil. Trans. 224. pp. 259–301, Nov. 13, 1924.)—The apparatus described makes use of two multi-vibrators of the Abraham and Bloch type. One of these has a frequency of 1 kilocycle per second and the other has a frequency which is usually 20 kilocycles per second. The most important feature of the wave-meter is the means whereby the frequencies are kept constant. The two multivibrators are kept in harmonic synchronism with each other by the help of the reinforced twentieth harmonic of the low-frequency multivibrator. This is accomplished by the help of a special selector circuit and amplifying valve arrangement, tuned to a frequency of 20 kilocycles per second. The two multivibrators are further both controlled in frequency by means of an electrically maintained tuning-fork, of frequency 1 kilocycle per second. This complete system therefore forms a source of electrical impulses of extremely steady and accurately known frequencies. The impulses from either multivibrator can operate on a selector circuit, consisting of a standard variable condenser of special design and a set of six inductance coils of small damping decrement. By this means two complete series of harmonics may be selected, covering a range between 10 and 1200 kilocycles per second. The frequencies produced do not depend on the constancy of any electrical circuit. A selective amplifier serves to amplify any selected harmonic, and by interference with an external source this latter may be set to exact synchronism with the harmonic. The seven main sections of the paper are as follows: (1) Introductory. (2) to (4) Principles of the multivibrator and experiments therewith to prove its suitability for the purpose in view. (5) Fundamental principles governing the design of the wave-meter. (6) General outline of the principal features of the construction, including the design of a condenser to give a uniform frequency scale. (7) Methods of using the wave-meter and the possibilities connected therewith. A. W.

671. *A New Apparatus for the Measurement of Magnetic Fields.* **F. Schröter.** (Zeits. Instrumentenk. 44. pp. 477–483, Nov., 1924. From the Reichanstalt.)—The paper is introduced by a brief survey of the various methods of measuring magnetic fields, and shows the difficulty of measuring both direction and strength of the field at the same time. The present instrument is simple in construction and working. A conducting strip (L), capable of bending, is placed between the poles, or in the homogeneous field under investigation. The strip is in series with a battery, adjustable resistance and an ammeter. The strip passes between two fixed contacts placed opposite to its centre and is supported at either end by two flat springs which can be adjusted by screws so that the tension on the strip can be varied at will. The current in the strip circuit is increased by adjusting the resistance until the strip is so far bent out of the normal that it touches one or the other contact. The making of contact is recorded in another circuit which includes a telephone and a small induction coil. The contact is easily heard. The mechanical force (K_1) necessary to bend the strip far enough to touch the contact is known and is constant under the fixed conditions.

The electromagnetic force (K_2) on the conductor strip is $K_2 = c \,.\, J \,.\, H_e$, where J is the current value in the strip and H_e the magnetic field component perpendicular to the strip, whilst c is a constant. When contact is made $K_2 = K_1 =$ constant.

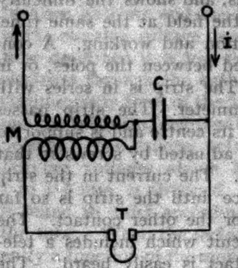
$$\therefore H_e = \frac{K_1}{cJ} = C\frac{1}{J}$$

where $C = \frac{K_1}{c} =$ constant. The effective field is therefore inversely proportional to the current strength in the strip at time of contact and is given by the ammeter. The latter can be calibrated to give direct readings of H. Variation of tension of the strip gives variation of the amount of displacement of the centre and hence variation in sensitivity. The instrument gives field strength and direction over a range from 10 gauss upwards to fields of considerable size. The paper includes details and discussion of constructional points and also a description, with results of experiment, of an actual working model. S. G. B.

ALTERNATING CURRENTS AND MAGNETISM.

672. *Deviation Coefficient for Wave-Forms.* **L. Legros.** (Soc. Franç. Élect., Bull. 4. pp. 915–934, Aug.-Sept.-Oct., 1924.)—A comparison of various rules for the deviation of wave-forms from a sine-wave. The proposed French standard rule prescribes a limit to the difference between the wave-shape and the sine-wave having the same effective value, referred to the maximum ordinate of the equivalent sine-wave. Results obtained from several observers showed that this rule is not reliable. No improvement is obtained by referring to the maximum ordinate of the fundamental. Analysis of the waves either by calculation or experiment appears to give consistent results up to the 15th harmonic. Above the 15th, experimental methods are preferable. Another proposal is to measure the effective value of the difference between the wave and the equivalent sine-wave. Several methods are suggested. R. G. J.

673. *The Measurement of the Natural Frequency of an Induction Coil.* **H. Mukiyama** and **K. Kobayashi.** (Phil. Mag. 48. 962–971, Nov., 1924.)—Campbell's frequency bridge was employed, an alternating current being supplied to the circuit from a triode valve oscillator; the frequency of the alternating current was determined by tuning the sound of the bridge telephone with standard tuning-forks, by adjusting the condenser of the triode valve oscillator. A modification of the bridge which enables perfect balance to be obtained is described. The unmodified circuit is shown in the figure. On balancing (1) $\omega = 1/\sqrt{MC}$, where $\omega = 2\pi f$ and f is the frequency, M is the mutual inductance and C the capacity of the condenser. If the primary coil, with self-induction L, is shunted by a capacity C_0, then (2) $\omega = 1/\sqrt{MC + LC_0}$ and (3) $\omega C_0 R = 0$, where R is the resistance of the primary; equation (2) can be satisfied by adjusting M or C, (3) cannot be satisfied strictly, so that the balance is not perfect, but (2) gives minimum sound in the telephone. If $MC + LC_0$ is written $M'C$, M' may be called the apparent mutual inductance, and $M' = M + C_0L/C$; C_0 may be simply the self-capacity of the primary, and C_0L/C is the correction to be added to M to obtain the apparent mutual induction M'. C_0 may be determined by this means. H. N. A.



674. *Reciprocal Relations in Alternating-Current Circuits.* **K. Matthies** and **F. Strecker.** (Archiv f. Elektrot. 14. pp. 1–15, Nov. 7, 1924.)—Let r = resistance, g = conductance, L = inductance, C = capacity, E = e.m.f. or p.d., I = current, z = impedance, a = admittance, and $\omega = 2\pi \times$ frequency. One class of reciprocal relations, which the author refers to as *resistance* reciprocity, has been previously studied by various writers; such reciprocal relations are characterised by the fact that the reciprocal is obtained from the original functional relationship by substituting g, C, a and E for r, L, z, and I respectively, ω remaining unchanged. The author considers a new kind of reciprocal relationship, which he terms *frequency* reciprocity, in which the passage from the original to the reciprocal relationship is obtained by substituting $-1/\omega$ for ω, and 1/C for L. The author introduces symbolic operators to denote the passage from the original to the reciprocal relationship, in the two cases of resistance and frequency reciprocity, and considers a third operator, which is represented by the product of the first two; he then shows that products of these three operators do not yield any further new operator.

The use of reciprocal transformations is illustrated by their application to the theory of wave propagation and wave filters. A. H.

675. *Undulating Current Magnetisation and its Measurement with Instruments containing Iron.* **M. Stöckl.** (Archiv f. Elektrot. 14. pp. 75–105, Nov. 7, 1924.)—A superposition of direct current upon symmetrical alternating current is defined by Heinke as undulating or wave current ("Wellenstrom"). The magnetic characteristics and also the form of the current resulting are of a distinctly different kind from ordinary cases. We can, therefore, differentiate between three types of magnetisation: (*a*) Direct-current magnetisation; (*b*) alternating-current magnetisation (symmetrical and cyclic magnetisation); (*c*) wave or undulating current magnetisation (asymmetrical and ascyclic). For purposes of investigation it is convenient frequently to divide the latter into its two constituents, the direct field and the alternating field. The paper is a record of a study of the latter form of current (*c*) and is divided into two parts. Part I deals with hysteresis loops, permeability and self-induction coefficients, phase angles, work done by hysteresis, and transformation of undulating current. Part II contains a detailed description of the theory and practical use of various types of instruments for measuring the various factors connected thereto, particularly the Ferrari instruments designed for the purpose. The paper, in both sections, is profusely illustrated by curves and tables, and the various formulæ are deduced which are necessary for theoretical treatment of the subject. S. G. B.

676. *Field Intensity Measurements in Washington on the Radio Corporation Stations at New Brunswick and Tuckerton, New Jersey.* **L. W. Austin.** (Inst. Radio Eng., Proc. 12. pp. 681–692, Dec., 1924.)—The paper gives the results of field intensity measurements at the Bureau of Standards on the transatlantic radio stations at New Brunswick and Tuckerton, New Jersey. The summer measurements are somewhat weaker than those of winter, and generally the afternoon signals are slightly weaker than those of the forenoon. The most interesting fact observed was the great increase in signal strength which accompanied the passage of the cold waves of January, 1924. This, if verified, will be of special interest as showing a definite connection between radio transmission and the usual weather phenomena. AUTHOR.

677. *The Barkhausen Effect.* **E. P. T. Tyndall.** (Phys. Rev. 24. pp. 439–451, Oct., 1924.)—In a typical experiment a strip of silicon (4·2 %) steel, after having been carried through several hysteresis cycles and brought to a steep part of the B-H curve, was subjected to a magnetic field, which was increased in a continuous manner by 0·13 gauss in 2 sec. To obtain a record of the discontinuities in magnetisation, the specimen was surrounded by a small search-coil connected through an amplifier to a moving-coil oscillograph. The oscillograph records show many almost instantaneous deflections, with a random distribution both as to time of occurrence and as to magnitude, each followed by an approximately exponential return to zero. The duration of an impulse depends probably on eddy currents in the specimen. A rough time-constant of 3×10^{-5} sec. is computed for a 4 % silicon steel wire 1 mm. in diameter. The apparatus was calibrated by means of artificial impulses of the same type. Assuming each impulse is due to a sudden saturation of a small portion of the material, the change in magnetic moment of this portion is found to vary from 0·001 to 0·008 e.m.u.; the average change 0·003 is sufficient to saturate a volume of $1{\cdot}7 \times 10^{-6}$ c.c. This volume, while comparable with that of a crystal grain in the particular case described, was found not to depend upon grain size in any marked degree in other experiments. The results favour the suggestion of Barkhausen that magnetic materials magnetise discontinuously, but leave open the question as to what determines the size and shape of the portions which suddenly change. AUTHOR.

678. *Report of the Committee on Magnetic Standards and Instruments and Methods of Aerial Magnetic Measurements.* **J. A. Fleming.** (Nat. Research Council, Bull. 7. pp. 110–115, Jan., 1924. Abstract of paper read before the Am. Geophys. Union, April, 1923.)—The report deals with (1) comparisons of magnetic and electric methods for determining the horizontal intensity of the earth's magnetic field. The outstanding work during the year was the completion of an indirect comparison between the Schuster-Smith magnetometer of England, the Watanabe electric magnetometer of Japan and the Carnegie Institution of Washington sine-galvanometer. The results show that the Schuster-Smith instrument and the sine-galvanometer give values differing by less than 1/10,000 part of H. The Watanabe instrument gives greater values by 1/3000 part of H, but the comparison is not quite so certain in this case. The provisional international magnetic standard for H, adopted in 1914 by the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, gives results agreeing within 1/5000 part of H with those from electromagnetic methods (excluding Japan). Comparisons of the Kew standard magnetometer with the Schuster-Smith magnetometer also show substantial agreement between the magnetic and electric instruments. (2) Maintenance of standards provisionally adopted by the Department of Terrestrial Magnetism. (3) Comparisons of magnetic standards at observatories. (4) Magnetic standards of the United States Coast and Geodetic Survey. (5) Development of instruments and methods for aerial measurements. Among other things under this heading considerable progress has been made at the Bureau of Standards in developing an earth inductor compass specially for use in aeroplanes. New features are: (*a*) Null method used for indications; (*b*) iron core used in the earth inductor to reduce size of instrument; (*c*) distant electrical control used, enabling earth inductor to be located away from magnetic material; (*d*) rolling and pitching errors eliminated. M. A. G.

679. *Reversible Magnetic Permeability.* **R. Gans.** (Zeits. f. Physik, 29. 5. pp. 270–271, 1924.)—Combats conclusions reached by Uller (Verh. d. D. Phys. Ges. (3) 5. 2. 1924) and maintains that for small variations the process of hysteresis is reversible in the thermodynamic sense. A. D.

680. *Magnetic Fields with Variable Velocity of Movement.* **N. Japolsky.** (Archiv f. Elektrot. 14. pp. 106–128, Nov. 7, 1924.)—The efficiency of electrical machines driven by multiphase current varies in such a manner that the velocity of the magnetic field does not remain constant, but continuously changes, corresponding to the variation of velocity of the moving part of the mechanism. In order to attain ideal conditions, the period and amplitude of the alternating electrical potential which is applied to the winding of the machine must be continuously altered during the acceleration of its moving parts. A description of such a machine is given in English Patents Specifications Nos. 214,392 and 12,581 of 1902 and also Abstract 706 B (1922). The present paper deals with the theoretical investigations underlying the principles of the machine and such magnetic fields. Firstly, a new terminology is evolved. "Magnetofugal" field is defined as a magnetic field, in chosen direction and form, produced by a multiphase alternating current. The electromagnetic system produced by a magnetofugal field is designated "magnetofugal state" (or magnetofugalstande). A system of current conductors which move in a magnetofugal field, or attempt to move, are defined as "magnetofugal runners" (or magnetofugallaufer). A differential equation is evolved for a system of conductors driven through a magnetofugal field, and with the help of this equation it is possible to deduce the characteristics of the movements of the "magnetofugal runners" in the different cases. Specific examples involving this formula are discussed and the whole principle is treated theoretically from first principles. The paper concludes with a note on the possible practical applications of the system, and suggests that a machine employing such fields is highly suitable for machines doing work of an impulsive nature, such as hammers, piledrivers, etc. The treatise is entirely theoretical. S. G. B.

681. *Demagnetisation and Hysteresis Loops.* **L. W. McKeehan** and **P. P. Cioffi.** (Optical Soc. of America, J. and Rev. Sci. Inst. 9. pp. 479–485, Oct., 1924.)—A series of tests are described carried out with "permalloy" in the form of strips and wires, carefully annealed and under no tension. The experimental method is the same as described by Cioffi previously [Abstract 2839 (1924)]. The curves now shown indicate the advantage of increment of the applied field to such a value that the permeability μ_Δ becomes twice its initial value μ_0, and thus the maximum permeability at exact demagnetisation is made much sharper by this change in ΔH. So that the larger values of ΔH would introduce certainty into the value of applied compensating field H_a, at which the value of μ_Δ is a maximum, the following procedure was adopted. The compensating field H_a was first established, and then the alternating demagnetising field was applied and reduced gradually to zero. The resistance in series with a second magnetising winding was so adjusted that closing the circuit through this winding added or subtracted a field half as great as the desired increment ΔH. By a commutator reversal switch in this circuit being operated several times, the applied field varies between $H_a \pm \frac{\Delta H}{2}$. Finally, a galvanometer deflection is taken for a single reversal in one direction or the other, and the value $\mu_\Delta = \frac{\Delta B}{\Delta H}$ is calculated. The paper includes results of experiments and conclusions drawn therefrom, which are embodied in a series of curves. S. G. B.

682. *Schematic Magnets.* **A. Schmidt.** (Terrest. Magn. 29. pp. 109–112, Sept., 1924.)—The potential produced external to a given distribution of magnetism can be approximated to, if the distribution of

magnetism is replaced by a system of schematic magnets—these being magnets with point poles. One or two simple cases are worked out.
A. A. D.

683. *The New Magnetic Network of France.* **E. Mathias.** (Annales des Postes Télé. 13. pp. 466–518, May, 1924.)—This is a long article, which falls into two parts. In the first the old network of magnetic stations, due to Moureaux, and the magnetic charts based on it, are reviewed, particular mention being made of the magnetic anomalies which were so discovered. In the second part the improvement of the network of Moureaux is studied, but first some numerical examples are given showing how the magnetic elements at any point of France, even in anomalous areas, may be obtained from the old network. The law of regular distribution of magnetic elements is sought, appearing as a function of the second degree of longitude and latitude, and the explanation and treatment of anomalies is gone into. The disappearance of some of the old stations and the likelihood of others following them as commercial electrification spreads, renders it necessary, in view of the importance of secular variation, to improve the network, and a description is given of progress already made.
M. A. G.

RADIOGRAPHY AND ELECTRO-PHYSIOLOGY.

684. *The Homogeneity of Dosage, in Quantity and in Time, in Deep Therapy.* **M. Joly.** (Archives d'Él. Médicale, 32. pp. 329–340, Nov., 1924.)—The author gives details of ionoquantimetric measurements with the water phantom to determine depth dosage in the form of isodosimetric curves of the type originally due to Dessauer. The author then advances the view that to avoid metastases the lethal carcinoma dose should be given at one treatment, but that, as this is not usually possible when the full dose has to be given in fractional doses, these should be given from different ports of entry in order to give an equal depth dose from each direction of radiation. The author then illustrates his method with special cases actually treated of colonic and rectal carcinoma, with and without other previous treatment, as colotomy or radium or diathermy. Most remarkable is the resulting improvement obtained with this type of neoplasm usually resistant to X-ray therapy.
B. J. L.

685. *A Simple Accessory in Radiation Therapy.* **P. A. Schultz.** (Phys. Zeits. 25. pp. 573–575, Nov. 1, 1924. Paper read before the Deut. Naturforscher u. Ärzte, Innsbruck, 1924.)—Describes a method of measuring the intensity of ultra-violet light when used for therapeutical purposes. The Linke actinometer is used and a subtraction method utilised in which the intensity is measured first via quartz glass specially non-absorbent to the radiation and then via a very absorbent glass, the difference of intensities giving the intensity of the ultra-violet radiation.

The dosage is determined by three quantities: (1) lamp voltage, (2) distance, (3) time. Curves are given showing the decrease in percentage ultra-violet radiation as the energy of the lamp is increased and more heat radiation is developed. The constancy of ultra-violet excitation over long periods of time upon which this method of dosage measurement is based is also discussed.
B. J. L.

CHEMICAL PHYSICS AND ELECTRO-CHEMISTRY.

686. *Principles of Gas Absorption.* **W. K. Lewis** and **W. G. Whitman.** (Indust. and Engin. Chem. 16. pp. 1215–1220, Dec., 1924.)—An outline is given of certain of the more fundamental conceptions which have been developed from the available data and from the general laws of reactions between two phases. The results deduced are briefly as follows: The rate of absorption of a gas by a liquid is controlled by the rate of diffusion of solute through the surface films of gas and liquid at the gas-liquid boundary. The relative importance of the two films is determined primarily by the gas solubility and to a less degree by the conditions of operation. Gas bubbles give very thin liquid films and are therefore particularly adapted to the absorption of the less soluble gases. On the other hand, the rates for the more soluble gases are limited by slow diffusion through the gas, this effect becoming increasingly evident with gases having solubilities greater than that of sulphur dioxide.

Absorption through free liquid surfaces is increased enormously by stirring the liquid. The same general considerations hold here as for gas bubbles, but the liquid film is thicker relatively to the gas film. For this reason the effect of the gas film is less noticeable with sulphur dioxide, although with more soluble gases it comes into prominence. T. H. P.

687. *Mechanism of Absorption of Moderately Soluble Gases in Water.* **H. G. Becker.** (Indust. and Engin. Chem. 16. pp. 1220–1224, Dec., 1924.)—Much of the matter here given has been already published [Abstract 1483 (1923)], the results obtained with a number of other gases being given. The absorption of a gas by stationary water appears to be a complex phenomenon and may occur in different ways according to the nature of the gas and its effect on the density, surface tension, and viscosity of the water. Thus, certain gases, such as carbon dioxide, hydrogen, and hydrogen sulphide, tend to saturate the surface layers of the water fairly readily, and the layers so formed are of considerable permanency and not easily dislodged. On the other hand, gases such as nitrous oxide, nitric oxide, and chlorine show no tendency to form such saturated surface layers and are absorbed at a correspondingly higher rate. T. H. P.

688. *Effect of Gas Velocity and Temperature on Rate of Absorption.* **R. T. Haslam, R. L. Hershey** and **R. H. Keen.** (Indust. and Engin. Chem. 16. pp. 1224–1230, Dec., 1924.)—The values of the over-all absorption coefficients have been experimentally determined for sulphur dioxide and for ammonia over the temperature range 10° to 50°, the velocity of the gas being varied from 0·03 to 1·5 feet per second. These coefficients have been investigated by means of the two-film theory, as developed by Lewis and Whitman [Abstract 686 (1925)]. The dependence of the individual film coefficients on gas velocity, temperature, and nature of the solute gas is considered. The velocity of the gas is without appreciable effect on the liquid film in the apparatus used by the authors, whereas the gas film coefficient is proportional to the (gas velocity)$^{0·8}$. The temperature influences the two individual film coefficients in widely different ways, the gas film coefficient being proportional to $T^{-1·4}$ and the liquid film coefficient to T^4. This divergence in behaviour is explained on the basis of the dependence of the gas and liquid film coefficients on the ratio of the density (s) to the viscosity (z) of the film fluid. This ratio increases with rise of temperature for the liquid film, and diminishes for the gas film, both individual film coefficients being proportional to $\left(\frac{s}{z}\right)^{2/3}$. These data support Lewis and Whitman's statement that the molecular diffusivities of all solutes are identical. The calculations are made on the assumption that this is true for the liquid film and the ratio of the calculated diffusion coefficients through the gas films, which should, according to theory, equal the ratio of the molecular weights, is within 15 % of agreement with this ratio, the molecular weight ratio being 3·76 and the specific diffusivity ratio 3·3.

T. H. P.

689. *Rate of Absorption and Equilibrium of Carbon Dioxide in Alkaline Solutions.* **R. V. Williamson** and **J. H. Mathews.** (Indust. and Engin. Chem. 16, pp. 1157–1161, Nov., 1924.)—The effect on the rate of absorption of increasing the rate of liquid flow under conditions of liquid surface varying from a perfectly smooth surface to a very turbulent one, and the result of increasing the rate of gas flow when a slight excess is already passing through the tower, have been studied. The rate of absorption of carbon dioxide in potassium carbonate solutions is practically independent of the concentration of potassium carbonate. It increases with a rise in temperature up to a maximum of 70° or 75° C. and then decreases as the temperature is increased. With the apparatus used, a 48 % decrease in the loss of carbon dioxide escaping from the tower and a decrease of 26 % in the time of operation were obtained under a given set of conditions by carrying on the absorption at 70° C. instead of 25° C., provided the absorption was stopped when a saturation of 65 % was obtained. An equation has been developed for calculating the rate of absorption of carbon dioxide in alkaline solutions. A method is given for determining equilibrium conditions for K_2CO_3, $KHCO_3$, and CO_2 at different temperatures with a minimum amount of experimental data.

AUTHORS.

690. *Seventh Report to the Corrosion Research Committee of the Institute of Metals.* **G. D. Bengough** and **R. May.** (Inst. of Metals, J. 32, pp. 81–256; Disc., 257–269, 1924.)—The report deals with the corrosion of copper zinc, 70 : 30 brass and condenser tubes and the protection of condenser tubes. The report is mainly concerned with the mode of formation and behaviour of "scales" which form on copper and brass in the presence of sea-water. The corrosion of copper in chloride solutions results in the formation of cuprous chloride, which undergoes a series of changes in the presence of air or oxygen, resulting in the formation of complex oxychlorides. Analyses of the products of corrosion of copper exposed to sea-water for long periods showed that they consisted of cupric oxychloride, cupric hydroxide, basic carbonate, and calcium sulphate. The protective value of scales formed on copper in sea-water is much less in rapidly flowing water than in stagnant or slowly moving water. The corrosion of brass (70 : 30) is studied in detail, and the effects of arsenic upon the rate of corrosion and the increase of the rate of corrosion due to increase in the speed of the water up to 25 ft. per sec. were determined. A proposal is put forward for preventing the corrosion of condenser tubes produced by high-speed aerated water streams. This consists of forming protective scales on the tube in certain defined conditions, and it is found that such scales are able to resist removal by the water stream for a period of nine months at least, a period during which two or three ordinary tubes would have failed in similar conditions. The other methods of tube protection are discussed, the electrolytic method in some detail. [See Abstract 1024 (1924).] F. J. B.

691. *Colloid Chemistry.* **E. K. Rideal.** (Roy. Soc. Arts, J. 72. pp. 830–836, Oct. 17; 836–844, Oct. 24, and pp. 849–854, Oct. 31, 1924. Cantor Lectures.)—Results are given of measurements of the surface energy of a number of different liquids including metals at their melting-points. In accordance with the Gibbs relation between surface concentration and the change of surface tension with concentration it follows that a solid surface will adsorb gases, liquids, or liquids and dissolved solutes if a diminution in the free surface energy of the system may be effected by such adsorption. A preferential adsorption occurs for those substances in which the reaction of adsorption proceeds with the greatest decrease in the free energy of the system. An insight into the mechanism of adsorption is given by the work of Hardy, Langmuir, and N. K. Adam on the surface tension of solutions and the interfacial tensions between liquids. Tabulated values are given which show that the decrease in free energy when a liquid is brought into contact with water or mercury is most marked when the liquid contains a reactive group such as the hydroxyl, ether and carboxyl groups for water and the halide and sulphide groups for mercury. The molecule is orientated through the attraction of a specially reactive part of the molecule during the adsorption. The bearing of this phenomenon on lubrication and on catalysis is discussed.

In the second lecture it is shown how the properties of suspensoid colloids in the form of either sols or smokes are related to the operation of surface forces. The precipitation of a small grain or potential colloid from solution is determined by the occurrence of a high dispersion coefficient ϑ, where $\vartheta = C/S$, C being the degree of supersaturation and S the solubility.

In the third lecture some properties of emulsoids are discussed. Emulsions are stabilised by the introduction of a substance which forms a film at the interface between the two liquids. A definite orientation of the active groups of the stabilising agent occurs in respect to the two liquids and the relative dimensions of the groups attracted by either liquid determines which liquid forms the disperse phase. Instances of the formation of balanced oil emulsions and their importance in biological phenomena are referred to. The properties of gels, notably their elasticity, rigidity and crystal form, are best interpreted on the assumption that the solid phase consists of a number of particles joined together to form relatively short fibrils or threads in the irregular meshes of which the mobile liquid phase penetrates. The action of mordants and dyes is referred to adsorption. The case is considered of gelatin in a dilute hydrochloric acid solution on the basis of the Donnan membrane equilibrium. The excess of osmotic pressure of the ions in the interior of the gel accounts for the swelling and the p.d. produced by the difference in ionic concentration is found to agree with the theoretical values. A *résumé* is given of the properties of soap sols. J. N. P.

692. *The Swelling of Colloids in the Presence of Capillary-Active Substances.* **F. V. v. Hahn.** (Zeits. Elektrochem. 30. pp. 453–459, Oct., 1924. Paper read before the Deut. Bunsen Gesell, Göttingen, 1924.)—Brinkman and v. Szent-Györgyi observed that collodion membranes, impermeable to certain colloids, become permeable after treatment with aqueous solutions of capillary-active materials. This might be because the pores of the membrane would open out with the swelling of the spherical particles of the membranes, though the rate of filtering need not be accelerated since the same membrane would then form a thicker layer. The hydration and dehydration is best studied by viscosity measurements with the aid of a modification of Beloff's method. A capillary tube is made of the gel in question and is used as a viscosimeter tube by passing first water and then the respective solution through the tube. The author and Miss Rocholl noticed that the viscosities determined changed with the age of the gel (hours or days). The dehydration is effected by means of either ether or chloroform; in the former (reversible) case the gel swells again on retreatment with water, in the latter (irreversible) case, not. Atropine and paraldehyde form a third type of compounds, acting first hydrating and, after washing with water, dehydrating. Narcotic effects do not appear to be due to surface activity. H. B.

693. *Stability of Colloidal Solutions. Part I. Aluminium Hydroxide Suspensions.* **K. C. Sen.** (J. Phys. Chem. 28. pp. 1029–1035, Oct., 1924.)—The stability of suspensions of aluminium hydroxide towards electrolytes was investigated. It was found that both the concentration and the amount of the peptising agent are important. In the case of aluminium hydroxide suspensions with benzoic, acetic and propionic acids, the stability of the suspensions depends on the concentration of the hydroxide and the acid present. Increase in concentration of the acid results in an increase of stability to a maximum. For a suspension of constant degree of purity the stability decreases with dilution. The results are in agreement with the law that the greater the concentration of a sol, the greater is its stability towards electrolytes. F. J. B.

694. *The Dissolution of Substances in Mixed Liquids, with Special Reference to Colloids.* **E. W. J. Mardles.** (Chem. Soc., J. 125. pp. 2244–2259, Nov., 1924.)—An investigation is made of the influence of mixed solvents in modifying the solubility relation of colloids compared with the value given with either solvent alone. An examination is made of the dissolution of a number of colloidal substances such as cellulose acetate and tannic acid in various binary mixtures of liquids the components of which are known to form, or are suspected of forming, molecular complexes on mixing. Measurements are made of the viscosity, surface tension, and of the amount of a third liquid necessary to cause precipitation of the colloid from the solution. A certain amount of evidence is put forward to support the hypothesis that the optimum solvent mixture frequently coincides with that of a simple molecular ratio. Curves are plotted showing the change of viscosity with variation in solvent composition. In general there is a tendency for the optimum solvent to give a sol of minimum viscosity. But the addition of a colloid to the solvent mixture exaggerates any peculiarities in the viscosity composition curve of the pure solvent. The surface tension and stability against precipitation give a relation parallel to that of viscosity. The effects observed are attributed to changes in the degree of association or aggregation of the solvent. It is considered that any change which tends to increase the molecular complexity of the dispersion medium causes a decrease in solvent action. The hypothesis is in accordance with the view frequently put forward that when the viscosity of a mixture is greater than the mean value it is due to the formation of a molecular complex, and, when lower, although the presence of a complex can be proved, the anomaly is due to molecular dissociation of the liquids. The use of a colloidal substance in the study of binary mixtures is held to be of value in that a small quantity added to a binary mixture exaggerates any divergence on account of the change in the degree of dispersion. [See Abstract 343 (1924).] J. N. P.

695. *The Protection and Precipitation of Gold Sols by Albumen.* **R. Zsigmondy** and **E. Joël.** (Zeits. phys. Chem. 113. pp. 299–312, Nov. 8, 1924.)—When a solution of NaCl, above a certain strength, is added to a solution of colloid gold the gold is precipitated, and the colour changes from red to blue. Gelatine, previously added to the gold solution in sufficient quantity, prevents this action, protecting the gold against the action of the salt, so that the colour remains red. If, however, the particles of the gelatine sol are fairly large, and the total number of particles is considerably smaller than that of the gold particles, there will be precipitation of the gold, with change of colour towards blue violet, with no NaCl or with quantities of NaCl below the threshold value; when the percentage of gelatine is still smaller the colour of the gold solution is unaltered. Tables show the remarkable colour relations, the zone of protection with large amounts of gelatine, the precipitation zone with smaller amounts and the indifferent zone with still smaller amounts. It is assumed that in the zone of protection all the gold particles are surrounded with gelatine particles; when the number of gelatine particles is diminished several gold particles attach themselves to one gelatine particle; the colour then changes, owing to the close approach to one another of the gold particles, and the aggregation causes precipitation; with a still smaller proportion of gelatine particles the majority of the gold particles remain unaffected, and the colour is unaltered. Most of the complicated phenomena observed receive a satisfactory explanation on this basis. H. N. A.

696. *Röntgenspectrographic Researches on the Nature of Swelling in Some Substances which give a Debye-Scherrer Diagram.* **J. R. Katz** and **H. Mark.** (K. Akad. Amsterdam, Proc. 27. 7–8. pp. 520–528, 1924.)—A Röntgenspectrographical examination is made of inuline and chitine when swelling in water and sodium palmitate when swelling in trochlorethylene. In the first two cases the vapour tension curve is found to vary continuously with the degree of imbibition, indicating that single hydrate formation is not obtained. The spectrographic measurements were made on the substances in the form of powders which were examined in tubes of thin nitrocellulose film which were fastened in the diaphragm aperture. In the case of inuline, the displacement in the diameter of the interference rings indicates that the water goes for the greater part into the crystal lattice and enlarges this in the same degree as the visible dimensions increase by swelling. The displacement of the rings amounted to from 8 % to 11 %, while the change of the dimensions corresponded to 11·5 %. With chitine and sodium palmitate, however, as with cellulose and fibroin, the spectrum does not change when the substances swell in the liquid in question. Consequently it appears that, according to the substance taken, imbibition can take place either intermicellarly or intermolecularly. J. N. P.

697. *The Application of the Ideal Solubility Curve to the Interpretation of Equilibrium Diagrams in Metal Systems.* **D. H. Andrews** and **J. Johnston.** (Inst. of Metals, J. 32. pp. 385–404; Corres., 405, 1924.) —Application is made of the van't Hoff reaction isochore $d\ln N_A/dT = \Delta H_A/RT^2$ where $\ln N_A$ is the natural log. of the molecular fraction present in the melt of A, the substance crystallising, ΔH_A, its molal heat of melting, or its heat of solution in the ideal case where no chemical combination occurs or no appreciable change of volume or heat content on mixing the components. On integrating this equation between the limits T and T_A, the melting temperature of pure A, and assuming H_A to remain constant with temperature, a relation is obtained of the form $\log N = a/T + b$, or the graph of log N against 1/T is a straight line, the slope of which is proportional to the heat of melting of the crystals in equilibrium with the solution. When this relation is followed it is concluded that the two metals form essentially an ideal system, and, conversely, if the graph is not linear, that the solution contains complexes or that the crystals separating are not of constant composition. By plotting a similar graph for the second component, both eutectic composition and temperature can be deduced. For this purpose that value of T is chosen at which antilog $(\log C_1)$ + antilog $(\log C_2) = 100$, where $C = 100\,N$. For a ternary system the process is similar except that in this case $C_1 + C_2 + C_3 = 100$. On testing this method by means of data obtained from a number of different types of metal systems, it is found that, in some of the simple cases, a straight line represents the experimental data closely. In other cases there is a regular divergence from the ideal curve, indicating that the effective molecular fraction differs from the gross molecular fraction, and corresponds presumably to some degree of compound formation in the melt. Systems which show limited series of solid solutions yield a form of curve which enables one to differentiate them from the simple eutectic type.

Conversely, if the eutectic temperature and composition are known, the solubility curve can be deduced merely by drawing a straight line between this point and the melting temperature of each pure component. It is found in the case of a number of metal systems which are investigated that even if the system is not altogether of a simple type, a straight line so drawn will give an approximation to the solubility curve. [See Abstract 1674 (1923).] J. N. P.

698. *Solubility, Heat of Solution and Lattice Energy of Salts.* **J. A. V. Butler.** (Zeits. phys. Chem. 113. pp. 279–289, Nov. 8, 1924.)—Discusses the relation between the heats of solution of salts and their solubilities. It is shown that there is close parallelism between these properties; the results support the theory that the solubility, as a first approximation, is determined by the heat of solution, modified by the special statistical conditions of the surface. Since the heat of solution is the difference between the sum of the heats of solution of the gaseous ions and the lattice energy, these are the fundamental magnitudes which determine the solubility. A series of tables contain the available data for a number of different salts; two of these contain the lattice energies and heats of hydration and solution of the halogen salts of monovalent metals, and the other similar quantities for bivalent metals. These confirm the addition rule of Fajans. H. N. A.

699. *Solubility of Portland Cement in Weathering Agents.* **H. K. Benson, J. S. Herrick** and **T. Matsumoto.** (Indust. and Engin. Chem. 16. pp. 1063–1066, Oct., 1924.)—The dissolved portion of Portland cement in distilled water is shown to consist almost entirely of calcium hydroxide, the amount dissolved on prolonged agitation being greater than that due to the hydrolysis of tricalcium silicate, which is known to be unstable; it is concluded, therefore, that the hydrated calcium silicates and aluminates are also hydrolysed. The solubility of hydrated Portland cement (*i.e.* after hardening for some months) is of the same order of magnitude. The presence of impurities, such as carbon dioxide and dissolved organic matter which shows an acid reaction, greatly increases the solubility of the cement in water. B. W. C.

700. *Studies in the Aluminium-Zinc System.* **T. Tanabe.** (Inst. of Metals, J. 32. pp. 415–452; Corres. 453, 1924.)—The equilibrium diagram of the aluminium-zinc system has been determined largely by means of electrical resistance and thermal expansion measurements. It is nearly coincident with that given by Hanson and Gayler [Abstract 2160 (1922)]. As the result of the measurements the nature of the transformation at 270° C. has been found to be a usual eutectoid change. This transformation occurs in alloys containing about 0·5 to about 75 % of aluminium. The nature of age-hardening in these alloys has been studied chiefly dilatometrically, assisted by measurements of hardness and spontaneous heat evolution. The results obtained by Hanson and Gayler have been confirmed except in a few cases. The occurrence of a maximum hardness during ageing has been elucidated by the colloidal theory. The hardness at high temperatures and the relation between the equilibrium diagram and the hardness have been investigated by the dynamic hardness test. It is found that there is abnormal change of hardness at 270° C. in all alloys containing eutectoid, and that there is no indication of the existence of the compound Al_2Zn_3, but only the softness of the β constituent at higher temperatures is shown. The mechanical properties of the alloys containing less than 24 % of zinc have been studied systematically, and the complete annealing zone of cold rolled alloys determined. A. A. D.

701. *The Alloys of Gold and Copper.* **E. Sedström.** (Ann. d. Physik, 75. 5. pp. 549–555, Oct., 1924.)—The properties of these alloys have been investigated by different observers, and the curves of melting-point, electric conductivity and thermoelectromotive force determined; the author in 1919 used the two last methods. In all cases the curves show a single maximum or minimum. X-ray measurements show the face-centred type of lattice throughout. Kurnakov, Zemczuzny and Zasedatelev, however, have recently obtained an electric conductivity curve, with three minima and two peaks, which indicate the existence of the two chemical compounds $AuCu_3$ and AuCu. The author has made a series of new measurements, using very pure gold and copper, melted *in vacuo* in quartz tubes lined with magnesia and cooled off very slowly.

After drawing out into wires, the alloys were heated to near the melting-point. The curves obtained indicate the existence of only one chemical compound among the alloys, AuCu. This particular alloy is very brittle; it has not as yet been examined by the X-ray method. Apparently the constitution of these alloys varies considerably with the method of preparation. H. N. A.

702. *Nickel and its Alloys.* (Bureau of Standards, Circ. No. 100 [162 pp.], Washington, 1924.)—In this circular the various physical properties of pure and commercial grades of nickel are described, together with a discussion of the relation of these properties to the composition and treatment of the material. The properties and applications of nickel and its commercially important alloys as Monel metal, nickel steels, ferro-nickels, copper-nickel and chromium-nickel alloys, and other alloys containing nickel are dealt with. Attention is given to those alloys now finding wide industrial applications by reason of their electrical resistance, heat-resisting and acid-resisting qualities. An extensive bibliography on nickel and its alloys is included.

703. *Hardness of Copper-Tin Alloys.* **O. Bauer and O. Vollenbruck.** (Zeits. f. Metallkunde, 16. pp. 426–429, Nov., 1924.)—The earlier work of Calvert and Johnson, Martens, Haughton and Turner, and Heap on the scratch hardness, Shore hardness, and Brinell hardness of copper-tin alloys is reviewed. A series of experiments were made upon copper-tin alloys of compositions varying from 98 % copper, 2 % tin to 99 % tin and 1 % copper, the hardness being determined by the Brinell method. Comparisons were made with the scratch hardness, the breadth of the scratch being compared with the Brinell hardness. It was found that the hardness of copper increased to a measurable but not great extent up to the limit of the α mixed crystal field (13·9 % tin). The greatest hardness was reached at the formation of the compound Cu_4Sn with 31·83 % Sn. The compound Cu_3Sn is softer than Cu_4Sn. Experiments on the quenching of the bronzes showed that up to 13·9 % tin, the quenching had no effect on the hardness. Only a slight increase of hardness took place when alloys with 16 % and 18 % tin were quenched. At 22 % tin a considerable reduction in hardness was observed after quenching. Alloys which have a β or γ structure are considerably softer in the quenched state. F. J. B.

704. *The Glow of Phosphorus.* **(Lord) Rayleigh.** (Roy. Inst. Proc. Advance Proof. Received Aug., 1924.)—A lecture in which the mechanism of the slow oxidation of phosphorus is described. [See also Abstracts 335 and 2860 (1924).] It is shown that the luminous oxidation of phosphorus is characteristic of the reaction between the vapour and the oxygen present. This reaction is continually being initiated at different points, but can only be propagated by the catalytic action of the phosphoric oxide present. Inhibition of the glow by ammonia or many organic compounds is due to catalytic "poisoning." Oxygen in excess also quenches the glow, and the mechanism is here doubtful. A supply of "poison" sufficient to prevent the initiation of the glow may not inhibit the propagation of the glow when once started, and in this way conditions may be obtained such that successive waves of luminosity travel through the gas. Photographs of the luminosity and of standing waves travelling against a steady gas stream are given. A. Wh.

705. *Potash from Cement Dust. Concentration by Elutriation.* **E. J. Fox and C. W. Whittaker.** (Indust. and Engin. Chem. 16. pp. 1044–1046, Oct., 1924.)—Fractions of cement dusts, the potash contents of which are approximately double those of the original materials, were obtained by air separation. In no instance was all the potash obtained in one fraction of the material, regardless of the size of the fraction. In all fractions of a given sample the potash content decreased as the size of the particles increased. The potash is apparently present on the surface of the dust particles, and the distribution of the potash over all surfaces is apparently equal. The concentration of potash obtained was apparently due to the increase in the aggregate surface obtained in the finer fractions. AUTHORS.

706. *Formation of Ammonia in the Oxy-Hydrogen Flame containing Nitrogen.* **H. Tominaga.** (Zeits. Elektrochem. 30. pp. 528–534, Nov., 1924.)—A preliminary account of the experiments, made under Haber, which the author cannot continue. Maxted's experiments [Abstract 800 (1919)] are criticised because he disregarded the dissociation of water-vapour and extrapolated Haber's formula, only intended for ammonia equilibria at low temperatures. The author's experiments are made at pressures up to 20 atmospheres with the pressure-flame apparatus used by Haber and Coates [Abstract 1660 (1910)] for the combustion of CO, but the platinum loop for ignition is replaced by a short quartz tube electrically heated. The flame is ignited and the pressure raised. Both NO and NH_3 were formed in nearly equal volumes. The yields were considerably higher than Maxted's, but smaller than expected; for high yields the flame should be low; then little H_2O_2 is formed. H. B.

707. *Preparation of Very Pure Barium and Strontium.* **P. S. Danner.** (Am. Chem. Soc., J. 46. pp. 2382–2384, Nov., 1924.)—In a further refinement of a method of preparation originally employed by Guntz, in which the alkaline earth oxide is made to react with Mg or Al, the desired resulting metal being isolated by distillation, a specially designed apparatus is used, by which the sample of metal can be transferred to another evacuated vessel while it is still sealed in the same vacuum in which it was distilled. A purity superior to 99·9 % is obtained, the pure metals being silver-white and highly crystalline. Both are quite soft and malleable—about as hard as metallic Na. Ba is spontaneously inflammable in moist air and H, and tarnishes rapidly in pure dry CO_2. Sr is only slightly less reactive. A. B. C. L.

708. *Reactions of some Glycols with Acetone. Space Configuration of Organic Molecules.* **P. H. Hermans.** (Zeits. phys. Chem. 113. pp. 337–384, Nov. 20, 1924.)—In order to account for the fact that the aliphatic isomeric compounds known are far less numerous than those considered possible, van't Hoff suggested that the two halves of a molecule might be capable of rotating about a C–C bond. The view was later supported by Böeseken's studies of certain boro-complexes and acetonic compounds and the increased acidity (measured by the electrolytic conductivity) of some hydroxyl derivatives of boric acid. The author shows, in agreement with Böeseken, that these complexes, 5- or 6-membered rings, are only formed when the organic compound contains two OH groups in the 1 : 2 or 1 : 3 positions, and when the space configuration is favourable; that is, when the two hydroxyls are on the same side of the molecule and in the plane of the two carbon atoms. The problems are studied theoretically (also thermodynamically) and experimentally by preparing such compounds and determining the equilibrium conditions and velocity of the reaction: diol + acetone = acetonic compound + water. The organic compounds in question are cis-hydrindendiol, *i*- and *r*-hydrobenzoin and two other diols. It would appear that the members of several groups of the same kind (several carboxyls, several phenyls, or hydroxyls) in the same molecule repel one another. H. B.

709. *Wood's Active Hydrogen.* **K. F. Bonhoeffer.** (Zeits. phys. Chem. 113. pp. 199–219, Nov. 8, 1924.)—Wood's active hydrogen [see Abstracts 546 (1922) and 53 (1923)] reduces a series of metallic oxides, sulphides, halides; it reduces S, As, P to H_2S, etc. It is reduced by appropriate catalysing walls to ordinary H_2, with evolution of heat measurable by thermometric means and by radiometer effects; one atom thickness is enough to produce this catalysis; many substances beside metals produce this catalysis; metals with higher over-tension are more effective than metals with lower, and the effectiveness of metals depends on the previous treatment. The percentage of the active hydrogen can be estimated from the thermal and chemical effects; it depends on the current-strength. The duration of the activity was measured by a chemical method.—The whole range of reactions, as well as Wood's spectral relations, can be explained on the assumption that the active hydrogen is atomistic. **Erratum** (*ibid.* p. 492, Nov. 20, 1924). A. D.

710. *Reactivity of Solid Phases.* **J. A. Hedvall.** (J. Phys. Chem. 28. pp. 1316–1330, Dec., 1924.)—Application of thermal analysis is able to give very reliable information as to reactions in pulverulent non-metallic as well as metallic substances. Many oxides of metals are very reactive, forming not only solid solutions, but also compounds with each other at comparatively low temperatures, and often at a surprising rate. In many cases the temperature of thermal dissociation can be easily determined, and the influence of the magnitude and form of the grains, and of the "preventive films," on the reaction process observed and preliminarily studied. The obvious difference in chemical and physical properties that very often can be observed for a great number of metal oxides according to their various modes of preparation follows from a different crystallographical development of the surface, but not from different space-lattices. These were unaltered in spite of very different methods of preparation of the oxides. In cases where really different modifications exist, their different reactivity can be shown with help of heating-curves. Many reactions which occur with astonishing intensity found and preliminarily studied in mixtures of peroxides with oxides or other peroxides. A new class of reactions discovered between solid phases; M′O + MAc = M′Ac + MO + H, where M′O, MO are metallic oxides whereof M′O is the more basic, M′Ac and MAc are salts of an oxygen acid, and H is the heat of reaction. A. D.

711. *Catalysis of H_2O_2 by Iron Salts.* **E. Spitalsky** and **N. Petin.** (Zeits. phys. Chem. 113. pp. 161–198, Nov. 8, 1924.)—Solutions of $FeSO_4$ used, from strongly acid to strongly aklaline. Contrary to the results of Manchot and Wilhelms and to the relations of complex salts of Fe-Cy-H acids, there was no co-existence of ferro-ions and H_2O_2; which tends to make improbable the theory of Bertalan as to the catalysing effect of a passage from a ferrous to a ferric condition. Catalysis in strongly acid solutions is homogeneous and exactly reproducible on repeating the action of the catalyser; it is independent of the initial concentration of H_2O_2 or the previous history; it is somewhat more complicated than direct linearity would give. Results of Bertalan, Duclaux and Bohnson confirmed as to direct proportionality between the speed of reaction and the number of iron ions and the inverse proportion of the speed with the H·-concentration. In feebly acid and neutral solutions the catalysis is developed during the formation of yellow basic precipitates, themselves inactive; the liquor contains iron-ions and hydroxyl-ions and is active, but its activity is inhibited by prolonged contact with the precipitate, which absorbs and coagulates; the catalysis is again homogeneous, during the formation of the precipitate. In weakly alkaline solutions red-brown precipitates of iron hydroxide are formed; this time the liquor is inert and the precipitate active, but the activity of the precipitate is soon lost. In strongly alkaline solutions, as in strongly acid solutions, the catalysis is homogeneous; if the concentration of H_2O_2 be small, the reaction terminates in a red-brown precipitation of iron hydroxide. Throughout the range from strong acidity to strong alkalinity we have action of iron-ions and hydroxyl-ions with formation of intermediate products, which formation is reversible; the concentration of these products determines the speed of the reaction, and in acid solutions this concentration can be followed by means of the colour of the solution, which falls off as the catalysis proceeds. **A. D.**

712. *Liquid Potentials at the Boundary of Alkali Solutions.* **R. Fricke and G. Rohmann.** (Zeits. Elektrochem. 30. pp. 537–544, Nov., 1924.)—Experiments were carried out in order to provide data for the electrometric estimation of the activity of OH ions in strong alkali solutions. Half cells of the usual construction were employed in conjunction with calomel electrodes, the potential being measured by the compensation method. The e.m.f. of cells of the type

$$\mathrm{Hg}\;|\;\mathrm{Hg_2Cl_2}\;|\;\tfrac{\mathrm{N}}{10}\mathrm{KCl}\;\underset{a}{|}\;\tfrac{\mathrm{N}}{10}\mathrm{HCOONa}\;\underset{b}{|}$$

$$\underset{b}{|}\;\tfrac{\mathrm{N}}{10}\mathrm{NaOH}\;\underset{c}{|}\;x\mathrm{N\,NaOH}\;\underset{d}{|}\;x\mathrm{N\,HCOONa}\;\underset{e}{|}\;\tfrac{\mathrm{N}}{10}\mathrm{KCl}\;|\;\mathrm{Hg_2Cl_2}\;|\;\mathrm{Hg}$$

was measured. The potentials at b and d will neutralise one another; c is calculated from Planck's formula and e from Henderson's formula. Then $c = \text{e.m.f.} + e - a$. It is found that the potential observed at high concentrations is always considerably greater than the value deduced from theoretical considerations. Chains of the type above were constructed which should give the same e.m.f. value, but were found to give lower values with increasing internal resistance of the chain, *i.e.* with more dilute solutions. Similar deviations from the calculated e.m.f. are observed when the diameter of the capillary tube, which forms the liquid boundary, is very small. The deviations observed are shown to be caused by polarisation in the liquid cell. The bearing of these results on the use of the capillary electrometer in laboratories for e.m.f. determination is discussed. The value of KCl bridging solutions in reducing the p.d. between two alkali solutions is illustrated, with concentrated solutions, this p.d. is not entirely eliminated. **B. W. C.**

713. *A Simple Apparatus for Electro-chemical Potential Measurements.* **M. Trénel.** (Zeits. Elektrochem. 30. pp. 544–548, Nov., 1924.)—The apparatus consists essentially of a porous porcelain cell surrounded by a glass cylinder, the whole dipping into the solution to be examined. The cell contains a platinum plate as positive electrode, and is filled with a quinhydrone solution as described in Abstract 363 (1924). The cell wall is soaked in a strong KCl solution, which is proved to minimise diffusion. The glass cylinder carries a small cylindrical platinum electrode, which is the negative pole. The p_H value is read directly on a specially constructed bridge which is calibrated for the quinhydrone solution used, and is graduated in units and tenths, being worked on the usual compensation method. A milliampere meter with rheostats and temperature scale is included so that temperature variations may be allowed for. The whole apparatus is compact and portable and suitable for field work in determining the acidity of the soil, etc., a single determination being made in about one minute, while the whole series of measurements may be made without the apparatus requiring any attention. Numerous examples of its employment in the potentiometric analysis of liquids are given, the p_H values being more accurate than those obtained colorimetrically. B. W. C.

714. *A Transportable Non-Sulphating Accumulator.* **E. Reynaud-Bonin.** (Annales des Postes, Télé. 13. pp. 1230–1234, Dec., 1924.)—The difficulties in the successful operation of ordinary lead-sulphuric acid accumulators are mentioned. Sulphation is due to the liberation of oxygen in the electrolyte, and Féry has developed a cell where the negative electrode is well removed from the field of diffusion of the oxygen in the air above the liquid. The employment of accumulators in telegraphic work is then considered, and the chief applications are ordinary accumulators for large exchanges and dry cells for very small exchanges. Between these two extremes there is the possibility of utilising these non-sulphating accumulators where medium traffic only is carried out and a source of energy is required not necessitating the constant attention such as can be obtained in the large exchanges. Such medium-size exchanges require that the accumulators, if unused, will retain their charge for weeks and months, and at the same time not be liable to sulphation. These non-sulphating accumulators are then described, and consist of lead plates, of which the negative is placed horizontally at the bottom of the cell. Movement of the acid is prevented by porous porcelain beads, and the concentration is so chosen that the state of equilibrium is suitable to the French atmosphere. The element is nearly completely enclosed, except for a small opening, so that repeated hydrations and evaporations are minimised, and the concentration does not greatly vary, satisfactory results having been obtained over three years' trial. The internal resistance of a 15-amp.-hours cell is 0·6 ohms.

Figures are finally given to show how closely these accumulators satisfy the desired conditions. B. J. L.

715. *Electrolytic Formation of Alloys and Amalgams of Manganese.* **A. N. Campbell.** (Chem. Soc., J. 125. pp. 1713–1719, Sept., 1924.)—Electrolytic production of Mn amalgam studied electromotively. Mn is deposited on a Pb kathode without depolarisation. Alloys of Mn and Ni, and of Mn and Fe, can be obtained by deposition from mixed electrolytes; these alloys are of low Mn content; there is no indication of a

Foerster effect. Unsuccessful attempt to depolarise Al discharge by means of Mn. A. D.

716. *Electrolytic Dissociation of Picric Acid in Aqueous Solution.* **H. v. Halban and L. Ebert.** (Zeits. phys. Chem. **112.** pp. 359–422, Sept. 30, 1924.)—By means of the photo-electric cell a highly sensitive comparison has been made between the intensities of colour of aqueous solutions of picric acid and sodium picrate. The conditions are laid down under which such comparisons may serve as a measure of the dissociation of picric acid, and a quantitative method developed capable of estimating the quantity of a true undissociated form of an acid. The results show that such undissociated form can exist only in minimum proportions in the cases of aqueous solutions of picric acid, β-dinitrophenol, and phenolphthalein. The values obtained colorimetrically for the degree of dissociation of picric acid for concentrations ranging from $c = 0{\cdot}0025$ to $c = 0{\cdot}04$ are appreciably greater than those formerly accepted. The fact that the molecular weight law does not hold for these degrees of dissociation is considered theoretically in the light of Bjerrum's views on the electrostatically conditioned activity of the ions, and curves are given representing α as a function of c. Without any essential additional assumption a satisfactory representation of the observed freezing-point depressions of picric acid in water is attained. By means of electrometric measurements of the hydrogen ion activity it is shown that the remarkably high "activity constant" of picric acid is to be attributed mainly to the picrate ion, and a connection between this conclusion and the peculiar behaviour of this ion in colloidal chemistry is indicated. Investigation of the equilibrium of picric acid renders it probable that organic molecular compounds of picric acid must be considered to be electrolytically dissociated in water. The solubilities of picric acid in salt solutions is interpretable in the sense of the electrostatic activity theory. Comparatively simple relations are shown by the distribution of picric acid between two liquid phases; in chloroform or bromoform solution the acid appears to be unimolecular. In 0·5 N-sodium chloride solution picric acid is more highly dissociated than in water. The values of the dissociation function of the acid in buffer mixtures of high electrolyte concentration agree with those required by Bjerrum's theory of the hydration of the hydrogen ion. T. H. P.

717. *The Thermodynamics and Kinetics of Liquid Chains.* **H. Schiller.** (Akad. Wiss. Wien, Ber. **132.** 2a. Nos. 9–10. pp. 353–365, 1924.)—Electrode potentials and diffusion potentials, *i.e.* potentials between points in electrolytes near the electrode, influence one another. The latter potentials should be eliminated in calculating electrode potentials, but the experiments of Fales and Vosburgh [Abstract 107 (1919)] throw doubt on the validity of Planck's formula in the case of HCl, KCl and HgCl. The thermodynamic methods of Helmholtz, Nernst, Planck and P. Henderson for the calculation of diffusion potentials involve the mobility of the ions, a quantity which should not enter into thermodynamic (equilibrium) equations. This was pointed out by H. A. Lorentz in 1916, who considered, moreover, that the methods of statistical mechanics could not cover the whole domain of thermodynamics. Debye then gave a kinetic theory of concentration cells, substituting molecular Brownian movements for the osmotic pressure, but retaining the representation of the electric field by a potential. The author examines the methods and theories mentioned, and also the late papers of Debye and Hückel [Abstracts 2328, 2541 (1923)], and comes to the conclusion that neither the thermodynamic nor the kinetic theories can be considered satisfactory. A thermodynamic method is in general inadmissible; the kinetic hypothesis of Debye involves assumptions which are not of kinetic character; a complete kinetic theory has not yet been given. The author does not accept Lorentz's view, however, that the methods of statistical mechanics and of thermodynamics could not entirely coincide. H. B.

718. *Electrolytic Evolution of Oxygen on Anode Polarisation.* **F. Jirsa.** (Zeits. phys. Chem. 113. pp. 241–247, Nov. 8, 1924.)—In alkaline solutions a palladium anode is oxidised by stages:—

$$\begin{array}{lccccc} & Pd \rightarrow & Pd_2O \rightarrow & PdO \rightarrow & PdO_2 \rightarrow & PdO_3, \\ \text{at} & & 0\cdot15, & 0\cdot4\text{–}0\cdot5, & 0\cdot95, & 1\cdot22 \text{ volts.} \end{array}$$

The anode therefore presents the stable PdO and PdO_2, a transitory Pd_2O, and an unstable PdO_3 which evolves oxygen and become PdO_2. A. D.

719. *Barium and Strontium Amalgam Electrodes.* **P. S. Danner.** (Am. Chem. Soc., J. 46. pp. 2385–2390, Nov., 1924.)—Three types of electrode vessel, based on the "dropping electrode" originally devised by Lewis and Kraus, are described and illustrated diagrammatically, modifications of design being introduced to overcome difficulties caused by the creeping of the solution between the amalgam and the glass wall of the dropper tip, and by the high reactivity of the concentrated 2-phase amalgams. The averages of the results obtained at 25° C. yield the following relationships: (1) Ba (2-phase amalgam), $BaCl_2(0\cdot1M)$, HgCl, Hg; $E = 2\cdot0240$. (2) Sr (2-phase amalgam), $SrCl_2(0\cdot1M)$, HgCl, Hg; $E = 2\cdot2472$. It is noted that the magnitude of these e.m.f.'s with respect to each other is in agreement with the idea that the bond between the very electropositive Ba and the Hg in their compound is a much firmer one than that between the less electropositive Sr and Hg, and is thus further evidence of the salt-like character of the mercurides. A. B. C. L.

720. *Electrochemical Polarisation and Electrode Reactions.* **E. Spitalsky.** (Zeits. Elektrochem. 30. pp. 491–493, Oct., 1924.)—In the study of the self-depolarisation of an electrode the real potential of the polarised electrode should be measured at controllable short intervals after momentary interruption of the polarising current, so far as possible without interference with the electrolysis. For this purpose the author uses a rotating commutator of the le Blanc type, consisting of three parallel discs adjustably mounted on the same shaft. Each disc operates, by the aid of a few teeth and recesses, a switch lever. The whole commutator turns from ten to thirty times per minute, and provision is made for effecting changes in the circuits within 0·01 second. The self-depolarisation of an electrode can be reproduced within a few hundredths of a volt, whilst the difference in the potential of the electrode on closed and on open circuit mostly amounts to several tenths of a volt. Brief mention is made of various investigations—*e.g.* the change of atomic into molecular oxygen. In the case of the platinum-hydrogen electrode the remaking of the polarising current after even the shortest interruption was not always sufficiently rapid for re-establishing the original state of the hydrogen electrode. H. B.

721. *The Ionisation of Strong Electrolytes.* **W. H. Rodebush.** (J. Phys. Chem. 28. pp. 1113–1117, Oct., 1924.)—Shows that the two empirical generalisations of Lewis and Linhart, the freezing-point law and the rule relating to activity coefficients as obtained from solubility data in mixed electrolytes, can be derived with some accuracy from Debye's theory. H. N. A.

722. *The Electrolytic Separation of Non-Noble Radio Elements.* **F. Tödt.** (Zeits. phys. Chem. 113. pp. 329–335, Nov. 8, 1924.)—The electrolytic methods employed by v. Baeyer, and by Hahn and Meitner, for depositing these elements on a platinum wire have been investigated in the cases of radium and its isotopes (ThX and AcX), thorium and its isotopes, actinium and mesothorium II. ThX was specially dealt with; when much calcium was present a minute quantity of barium was added to act as carrier for the ThX, and was precipitated with chromic acid, the calcium remaining in solution; the chromate precipitate was dissolved in HCl, and deposited electrolytically with a small excess of acid, a stream of CO_2 being passed through the liquid, and a high current density employed. In this way the precipitation of carbonate is confined to a narrow alkaline zone close to the cathode, on which the precipitate settles. Thorium in weakly acid solutions precipitates, when electrolysed, in thick flakes of thorium hydroxide, owing to the OH ions left behind when H is produced at the cathode; these flakes do not in general form a solid layer on the cathode. To get over this difficulty a strongly acid solution is necessary, so that the alkaline zone is reduced to a diffusion layer of 20–50 μ in thickness. The excess of H^+ ions up to this layer prevents a premature production of flakes, since positive colloids, such as $Th(OH)_4$, are peptised by H^+. It is shown that in the case of mesothorium II also the deposition is due to precipitation at the cathode, and that here, as in the other cases, the current only affects matters by bringing the necessary ions to the electrode. H. N. A.

723. *Theory of the Electrolytic Double Layer.* **O. Stern.** (Zeits. Elektrochem. 30. pp. 508–516, Nov., 1924. Paper read before the Deut. Bunsen Gesell., Göttingen, 1924.)—Starting from the old experiment that silver foil, immersed in silver nitrate solution, becomes covered with a film of silver ions, the author examined the double layer theories, the molecular condenser of Helmholtz and the diffused double layer of Gouy and Chapman, first without considering the forces of adsorption, and the electrokinetic potential of Freundlich. Assuming that the double layer may be replaced by a condenser having the one homogeneously-distributed charge in the solid surface, the other likewise homogeneously-distributed charge in the solution, and further a space charge of decreasing density in the interior of the solution, he finds a complex formula covering the theories of polarisation capacity, electrocapillary curve and electrokinetic potential with the aid of certain simplifying hypotheses. The polarisation capacity, it is deduced, is almost equal to the capacity of the molecular condenser, although the predominant part of the change is diffusely distributed; the electrokinetic potential is much smaller than Nernst's thermodynamic potential, and may be of opposite sign; and the shape of the electrocapillar curve and the electrokinetic potential will depend upon the salt concentration and the adsorption potentials of the two ions of binary salts, which are alone considered. H. B.

724. *Overvoltage of Hydrogen at Arsenic Kathodes. Electromotoric Behaviour of Arsenic Hydride.* **G. Grube.** (Zeits. Elektrochem. 30. pp. 517–523, Nov., 1924. Paper read before the Deut. Bunsen Gesell, Göttingen, 1924.)—According to Tafel and to Thiel [Zeits. anorg. Chem. 132. p. 15, 1924] the rate of liberation of hydrogen from the kathode would not so much depend upon the solubility of hydrogen in the kathode (Nernst) as upon the change of atomic into molecular hydrogen. According to Foerster, the hydrogen forms primarily alloys with the kathode which are quickly decomposed again. The author and H. Kleber study this problem by liberating hydrogen from arsenic kathodes (arsenic deposited on copper). Some AsH_3 is always liberated from such kathodes, and the question is whether this hydride determines the overvoltage. If the electrolytic formation and spontaneous decompositions of the hydride at an arsenic electrode were reversible, the overvoltage of the hydrogen liberation should be identical with the potential which the spontaneous decomposition of AsH_3 imparts to an As-kathode. This is confirmed under certain conditions by experiments made mostly in caustic soda or potash (also in sulphuric acid). In the *Discussion* by **Bodenstein, Foerster** and **Manchot** doubt was expressed whether cause and effect were not confounded, and whether the presence of alkali itself decomposing the AsH_3 did not complicate the reactions. H. B.

725. *The Measurement of Hydrogen-Ion Concentrations with Glass Electrodes.* **W. E. L. Brown.** (Journ. Sci. Instruments, 1. pp. 12–17, Oct., 1924.)—When two watery solutions are separated by a thin membrane of a suitable glass, a potential difference is set up between them which depends on their hydrogen ion concentrations. Glass electrodes made on this principle can be used to measure hydrogen-ion concentrations when the ordinary hydrogen electrode is useless on account of the presence of oxygen, etc. Special precautions are necessary in measuring the e.m.f. on account of the high resistance of the electrode. AUTHOR.

726. *Structure of Electro-chemical Deposits.* **R. Audubert.** (Rev. de Mét. 21. pp. 567–584, Oct., 1924.)—This is a general paper in which the author seeks to correlate the experimental data furnished by many observers. Metallic electro-chemical deposits are divided into four groups. In Group I the speed of formation of the crystals is greater than the speed of formation of the nuclei. This group yields large crystals. In Group II the aforementioned speeds are approximately the same. To this group belong the structures with fine grains. In Group III the nuclei form more quickly than the growth of the crystals. In this category the deposit is pulverised. Group IV relates to spongy deposits. The sponginess is due to the simultaneous liberation of hydrogen along with the deposited metal. The conditions of a deposit of this fourth type are considered in some detail.

The various factors influencing the nature of the deposit are next considered. The first is the nature of the electrolyte. It would seem that in general for fine compact deposits complex salts are advantageous, in particular the cyanides. The nature of the deposit is also very much influenced by the presence of very small quantities of colloids in the solution; some examples of this effect are quoted. In addition to colloids the presence of other foreign substances in the electrolyte improves the quality of the deposit, in particular the presence of acids and also various organic substances. Other factors considered are (1) the current strength, (2) the temperature, (3) the effect of stirring the electrolyte, (4) the nature of the metal upon which the deposit is effected, (5) the concentration of the electrolyte. **A. A. D.**

727. *Supposed Influence of Light on Electrophoresis.* **K. Schaum** and **P. Friederich.** (Zeits. wiss. Phot. 23. pp. 98–101, Dec., 1924.)—In view of the supposed influence of light on the velocity of particles subjected to electrophoresis mentioned by Young and Pingree [Abstract 783 (1914)], the behaviour of a number of hydro- and organo-sols has been investigated. The results show that the electrophoretic velocity of migration (u) is proportional to the external e.m.f. All the sols and suspensions examined show in long-waved and in ultra-violet light the same specific value for u with the exception of (1) zinc hydrosol, which under ultra-violet irradiation exhibits a slight diminution in the velocity of migration, this being attributable in the first place to a chemical influence (with zinc alcoholosol this phenomenon does not appear); (2) hydrosols of silver halides, the electrophoresis of which is influenced very considerably by light, the direction of the movement being reversed in some cases. Probably some of the positive results obtained in this connection are due to alteration of the magnitude of the particles and of the potential of the double layer as a result of chemical or photochemical processes. **T. H. P.**

728. *The Hydrogen Electrode Function of Platinum.* **K. Horovitz.** (Akad. Wiss. Wien, Ber. 132. 2a. No. 9–10. pp. 367–373, 1924.)—It is shown in this paper that a platinum wire, by an alteration of the hydrogen-ion concentration of the solution, experiences an alteration of e.m.f. in the same sense as a hydrogen electrode, but that the value of the e.m.f. of the acid-alkali chain is smaller. A. E. G.

729. *Anodic Gold Oxidation.* **F. Jirsa** and **H. Jelinek.** (Zeits. Elektrochem. 30. pp. 534–537, Nov., 1924.)—A solution of auric nitrate is prepared by anodic oxidation of gold in nitric acid solution. The excess of auric hydroxide which separates by hydrolysis is kept in contact with a definite concentration of heated nitric acid for an hour in order to attain equilibrium when the amount of gold in solution is determined. The value of the solubility product for the term $Au \times (OH)^3$ is found to be $5 \cdot 5 \times 10^{-46}$, which agrees approximately with the value of 9×10^{-46} previously derived from the solubility of auric hydroxide in sulphuric acid. The solubility of auric hydroxide in water is calculated from the present found value of the solubility product to be $2 \cdot 4 \times 10^{-12}$ grm. mol. per litre. In a further investigation of the solubility of auric hydroxide in sulphuric acid it is concluded that this solution leads to the formation of $HAu(SO_4)_2$, since it is only on this assumption that a constant is obtained for the mass-action equilibrium when employing varying concentrations of acid. On the basis of this reaction the affinity constant of auric hydroxide is calculated to be $1 \cdot 1 \times 10^{-6}$, or the basicity is comparable with that of hydrazine (3×10^{-6}). Potential measurements of gold in auric nitrate give a value for the normal potential $Au \rightarrow Au^{\cdots}$ of 1·37 volts, which differs by only 0·02 volt from a previously determined value [see Abstract 2650 (1924)]. J. N. P.

730. *Dielectric Polarisation.* **L. Ebert.** (Zeits. phys. Chem. 113. pp. 1–27, Oct. 18, 1924.)—A study of the molecular polarisation P. This consists of parts, which depend differently upon the chemical structure of the molecule; these parts require separate study. The orientation-polarisation P_0 is practically the same throughout the group H_2O-alcohols in the gaseous condition; the dipole-moments cannot differ widely. Different kinds of association are required to explain results. In homologous series the smaller the molecule the greater the association of the dipole-molecules. In substances with many dipole groups the symmetry of the molecule governs the aggregate moment. When there is little symmetry, P_0 is large. The value of P_0 stands in relation to the Kerr constant. When the molecule is small, the van der Waal's attraction between dipolar molecules comes to differ from that between quadripolars of about the same size. In mixtures it is, on account of the different association-values, necessary to trace out the different components of P; there is no general rule applicable. The moments of complex ions and of saline dipolars are much greater than those of aliphatic dipolar molecules or of water; in such substances deformation of the ions may result in change of colour and affect part of the energy of association. A. D.

731. *Magnetochemical Effects.* **A. Schükarew.** (Zeits. phys. Chem. 113. pp. 441–463, Nov. 20, 1924.)—The current which flows between two platinum plates immersed in various reacting liquids—*e.g.* KI + $FeCl_3$—is termed the current of chemical polarisation, and is shown to exist in some cases where the reaction has ceased—*e.g.* ZN + H_2SO_4—and to be produced also by mechanical alteration of the structure of the zinc. This current falls off rapidly with the time in the reaction KI + $FeCl_3$, but soon attains practically a constant value, and this stage is selected for the study of the effect of the magnetic field. The apparatus is described, by which it is shown that the magnetic field produces a current when the platinum plates are arranged asymmetrically with regard to the lines of force of the field. Similar magnetic effects are observed in various reactions, and also in the reaction $2NO + O_2$; the magnetic effects in flames—*e.g.* burning hydrogen—are also described. It is claimed that this induced current may be used to detect I_2 in KI solution, giving a more sensitive end-point in titrations than starch indicator. Much stronger magnetic effects are observed in electrolytic processes. The separation of the halogens appears to be the most influenced, but the induced current flows in different directions in different cases, no clear explanation of the phenomenon being as yet available. Complex ions do not in general show the effect. The author then describes the arrangement of apparatus by which the horizontal and vertical components of this magnetically induced current may be investigated, and it is shown that the effect is only produced in a certain well-defined region surrounding the electrodes. The nature and extent of the effect is fully described in the case of 10 % $BaCl_2$ solutions involving the separation of chlorine, and of $BaBr_2$ solutions with separation of bromine. Experiments are also described in the case of electrolysis without electrodes, as carried out by Pisarzewski. No satisfactory explanation of the mass of experimental facts collected in this paper has yet been arrived at. B. W. C.